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REPORT OF THE
COMMISSION OF INQUIRY
ON
THE FLUORIDATION OF
PUBLIC WATER SUPPLIES

*Presented to the House of Representatives by
Command of His Excellency*

BY AUTHORITY:
R. E. OWEN, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND—1957

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*Commission to Inquire Into the Desirability or Otherwise of the
Fluoridation of Public Water Supplies*

C. W. M. NORRIE, Governor-General

To all to whom these presents shall come, and to WILFRED FOSBERREY STILWELL, Esquire, Judge of the Arbitration Court; NORMAN LOWTHER EDSON, Esquire, Professor of Biochemistry; and PERCY VERNON ESMOND STANTON, Esquire, Merchant:

GREETING:

WHEREAS it is alleged that the fluoridation of public water supplies may benefit dental health: and whereas it is also alleged that the fluoridation of public water supplies causes ill-health: and whereas it is also alleged that local authorities should not be permitted to add fluoride to the water supplies: and whereas it is also alleged that there are practicable methods of adjusting the daily intake of fluoride other than by addition to the water consumed:

Now, therefore, pursuant to the Commissions of Inquiry Act 1908, I, Lieutenant-General Sir Charles Willoughby Moke Norrie, the Governor-General of New Zealand, acting by and with the advice and consent of the Executive Council, hereby appoint you, the said Wilfred Fosberrey Stilwell, Norman Lowther Edson, and Percy Vernon Esmond Stainton, to be a Commission to inquire into and report upon the following matters:

- (1) Whether benefits to dental health may reasonably be expected in New Zealand from the addition of fluoride to public water supplies, having regard to the results of the fluoridation of water supplies in other countries;
- (2) Whether any disadvantages may result from the addition of fluoride to waters naturally containing less than one part of fluoride per million;
- (3) Whether it is desirable or expedient that local authorities should be permitted to decide on such addition for the benefit of residents, particularly children, of their districts;
- (4) Whether there are any practicable methods of adjusting the daily intake of fluoride other than by addition to the water consumed;
- (5) Whether, and to what extent, the Government should take any steps in relation to the powers or actions of local authorities in respect of any of the foregoing matters;

and generally to inquire into and report upon such other questions coming to your notice in the course of your inquiries into the foregoing matters as you consider should be investigated in connection therewith:

And with the like advice and consent I hereby appoint you, the said Wilfred Fosberrey Stilwell, to be Chairman of the said Commission:

And you are hereby authorised to conduct any inquiry under these presents, in accordance with the Commissions of Inquiry Act 1908, at such times and places as you deem expedient, with power to adjourn from time to time and place to place as you think fit; and these presents shall continue in force whether or not the inquiry is regularly continued by adjournments as aforesaid:

And it is hereby declared that the powers hereby conferred shall be exercisable notwithstanding the absence at any time of any one of the members hereby appointed, so long as the Chairman or a member deputed by the Chairman to act in his stead and one other member are present and concur in the exercise of such powers:

And it is hereby further declared that you have liberty to report your proceedings and findings under this Commission from time to time if you judge it expedient so to do:

And, using all due diligence, you are required to report to me in writing under your hands, not later than the 15th day of February 1957, your findings and opinions on the matters aforesaid, together with such recommendations as you think fit to make in respect thereof:

And you are hereby strictly charged and directed that you shall not at any time publish or otherwise disclose, except to me in pursuance of these presents or by my direction, the contents or purport of any report so made or to be made by you.

Given in Executive Council under the hand of His Excellency the Governor-General this 6th day of November 1956.

T. J. SHERRARD, Clerk of the Executive Council.

*Extending Period Within Which the Commission Appointed to Inquire
Into the Desirability or Otherwise of the Fluoridation of the Public
Water Supplies is to Present its Report*

C. W. M. NORRIE, Governor-General

To all to whom these presents shall come, and to WILFRED FOSBERREY STILWELL, Esquire, Judge of the Arbitration Court; NORMAN LOWTHER EDSON, Esquire, Professor of Biochemistry; and PERCY VERNON ESMOND STANTON, Esquire, Merchant:

GREETING:

WHEREAS, pursuant to the Commission of Inquiry Act 1908, you, the said Wilfred Fosberrey Stilwell, Norman Lowther Edson, and Percy Vernon Esmond Stainton, were appointed, on the 6th day of November 1956, to be a Commission to inquire into and report upon the desirability or otherwise of the fluoridation of public water supplies:

And whereas it is expedient that the time for so reporting should be extended:

Now, therefore, I, Lieutenant-General Sir Charles Willoughby Moke Norrie, the Governor-General of New Zealand, acting by and with the advice and consent of the Executive Council, hereby extend until the 31st day of May 1957 the time within which you are so required to report:

And I hereby confirm the said Commission save as modified by these presents.

Given in Executive Council under the hand of His Excellency the Governor-General this 13th day of February 1957.

T. J. SHERRARD, Clerk of the Executive Council.

Extending Period Within Which the Commission Appointed to Inquire into the Desirability or Otherwise of Fluoridation of Public Water Supplies is to Present its Report

C. W. M. NORRIE, Governor-General

To all to whom these presents shall come, and to WILFRED FOSBERREY STILWELL, Esquire, Judge of the Arbitration Court; NORMAN LOWTHER EDSON, Esquire, Professor of Biochemistry; and PERCY VERNON ESMOND STANTON, Esquire, Merchant:

GREETING:

WHEREAS, pursuant to the Commissions of Inquiry Act 1908, you, the said Wilfred Fosberrey Stilwell, Norman Lowther Edson, and Percy Vernon Esmond Stainton, were appointed, on the 6th day of November 1956, to be a Commission to inquire into and report upon the desirability or otherwise of the fluoridation of public water supplies:

And whereas on the 13th day of February 1957 the time for so reporting was extended to the 31st day of May 1957:

And whereas it is expedient that the time for so reporting should be further extended:

Now, therefore, I, Lieutenant-General Sir Charles Willoughby Moke Norrie, the Governor-General of New Zealand, acting by and with the advice and consent of the Executive Council, hereby further extend until the 15th day of July 1957 the time within which you are so required to report:

And I hereby confirm the said Commission save as modified by these presents.

Given in Executive Council under the hand of His Excellency the Governor-General this 5th day of June 1957.

T. J. SHERRARD, Clerk of the Executive Council.

COMMISSION OF INQUIRY INTO THE DESIRABILITY OR
OTHERWISE OF THE FLUORIDATION OF THE PUBLIC
WATER SUPPLIES

TO HIS EXCELLENCY THE GOVERNOR-GENERAL of the Dominion of New
Zealand.

MAY IT PLEASE YOUR EXCELLENCY,—

We, the undersigned Commissioners appointed by Warrant dated 6 November 1956, have the honour to present to Your Excellency our report upon the terms of reference stated in that Warrant.

We were originally required to present our report by 15 February 1957 but this date was extended by later Warrants to 15 July 1957.

We have the honour to be,
Your Excellency's most obedient servants,

W. F. STILWELL, Chairman.

N. L. EDSON, Member.

P. V. E. STANTON, Member.

Dated at Wellington this 10th day of July 1957.

Report

PREFACE

PUBLIC hearings upon the terms of reference took place as indicated in the following order namely:

Hastings . . . . .	.	.	26 to 30 November and 3 to 4 December 1956 inclusive.
Auckland . . . . .	.	.	7 December and 10 to 12 December 1956 inclusive.
Dunedin . . . . .	.	.	12 to 14 March 1957 inclusive.
Christchurch . . . . .	.	.	18 to 19 March 1957 inclusive.
Wellington . . . . .	.	.	16 to 18 April 1957 inclusive.

Each such hearing was notified to the public of the appropriate district by advertisement in the daily newspapers circulating therein. The terms of reference were set out in detail and those desiring to give evidence were advised on the manner in which submissions should be lodged before the hearing. All persons who appeared and wished to give evidence were heard and in many instances submissions were received without personal appearance. A total of 121 witnesses gave evidence in person and of these 7 appeared more than once.

The Commission had the assistance of the following counsel at the public hearings:

Mr A. O. Woodhouse, Crown Solicitor of Napier (counsel to assist the Commission).

Mr H. W. Dowling, of Napier, represented certain witnesses heard at the Hastings sittings.

Mr F. C. Jordan, of Auckland, represented certain witnesses heard at the Auckland sittings.

Mr R. T. Heath, of Hastings, counsel for Mrs Van Asch.

Throughout this report references to the evidence are in terms coinciding with the method used in the bound volumes of the original record of evidence.

All references to publications are briefly put but will be found in extended form in the Bibliography contained in Appendix A hereto.

Accompanying this report are separately bound Volumes Nos. 1 to 10 containing the evidence as recorded and the exhibits produced together with the submissions of parties appearing themselves or by counsel on their behalf. Written submissions received since the last public hearing are included in Volume 10.

The Commission wishes to record the generous assistance it has generally received from counsel representing the various organisations or individuals in these proceedings.

To counsel appointed to assist the Commission, Mr A. O. Woodhouse, the Commission is most indebted for the very able and helpful manner in which he has discharged his duties.

Mr G. P. Comeskey has performed his duties as Secretary to the Commission with commendable application and efficiency. He has been ably assisted by Mr K. E. Swann.

The Commission would like to acknowledge the excellent and accurate work of the stenographers and typists who recorded the voluminous and often highly scientific evidence.

Having carefully considered the evidence presented to it the Commission finds and reports as follows. See report of 1900

*Part I***INTRODUCTION**

1. The proposal known as "Fluoridation of Public Water Supplies" involves adding fluoride to a potable water in order to raise the concentration of fluoride to the level which the advocates of the process consider to be the optimum. This optimum or ideal concentration is determined by them in relation to the point at which fluoride will reduce the prevalence of the disease known as dental caries (dental decay) to the greatest extent without risk of harm in any respect. Because the effectiveness of the process depends upon the amount of water habitually consumed in the community for drinking purposes, climatic conditions must affect the fixing of the optimum concentration. With slight variations dependent on this factor in particular, the ideal concentration is said to be one part of fluoride in a million parts of water (1 ppm).

2. At the outset it should be stated that few, if any, water supplies anywhere are completely lacking in fluoride. In New Zealand all the public water supplies which have been tested contain naturally occurring fluoride; but the issue of fluoridation has arisen in this country because these supplies contain considerably less than 1 ppm of fluoride. This fact has not been questioned. It is proposed that the natural concentration be increased to the ideal concentration.

3. The effect of fluoride on tooth structure and the incidence of dental caries in relation to the concentration of this substance in drinking water has been the subject of increasing research over many years. About twelve years ago the process was inaugurated in the United States of America and Canada. By that time public health authorities in those countries considered that there was ample justification for this action because they believed the effects of fluoride on dental health and on bodily health were well known.

4. Since the inauguration of fluoridation in the United States and Canada considerable discussion has taken place in many parts of the world as to the effects of the process, and arguments both for and against fluoridation have been disseminated widely by means of publications originating in numerous countries. There is no doubt that a great volume of relevant literature exists. It has been stated that there are several thousands of such publications. We are satisfied that a fair sample of these has been submitted for our consideration or cited by various witnesses.

5. Fluoridation was introduced in this country for the first time at Hastings and several witnesses have told us the purpose was to demonstrate that the process could achieve a worth-while reduction in the prevalence of dental decay in a typical New Zealand community. These witnesses described the incidence of dental decay as alarmingly high in this country. That evidence is uncontested. Nevertheless, the public

controversy which has taken place overseas in regard to fluoridation was duplicated here, and we have had the advantage of listening to the views of numerous individuals able to speak about the addition of fluoride to the public water supply at Hastings.

6. As the inquiry developed, it became obvious that this Commission has been faced with a complex problem in public health. The proposal has necessarily involved a consideration of many matters concerned with dentistry, medicine, chemistry, the mechanics of public water supplies, and sciences ancillary to these subjects. In addition to the requisite detailed examination of the many technical questions raised, there has been much discussion of questions related to liberty in modern democracies. In all these fields we have been aided by a great deal of evidence from witnesses drawn from various sections of the community.

7. The supporters of fluoridation in various centres have submitted evidence intended to prove that fluoridation is effective and harmless. They advocate the process because they consider it will reduce the prevalence of dental decay by at least half and enable about one-third of the children to avoid the disease altogether. In this connection they point to the fact that virtually every child in the country is at present subject to the disease. These witnesses expect that benefits will be carried forward into adult life. Included in the body of witnesses supporting fluoridation are the persons who supplied the great weight of orthodox scientific and technical evidence. It was put forward by dental, medical, and scientific witnesses eminent in their special fields of work. In general these witnesses adopted the method of pointing to observed scientific facts and then attempted to describe what they regarded as the inevitable conclusions to be drawn from those facts on grounds of logic and reason.

8. The opponents of fluoridation have based their arguments on a wide variety of grounds. These include the effects of fluoride on the human body, the possible use of other means of preventing dental decay, the legality of the process, and objections derived from their conception of personal freedom. These witnesses were mainly citizens, or groups of citizens, who considered that the process was dangerous, or might be dangerous, or that it would involve transgression of their rights and liberties as individuals. As laymen, doubting the harmlessness of a highly technical proposal, they were undoubtedly exercising a right which in our view should be regarded as a matter of the greatest importance at a time when communities are becoming increasingly dependent on the integrity of scientists. This general consideration, in addition to the particular significance attached to the fluoridation proposals, has caused us to weigh with care each of the arguments of all these lay witnesses whether or not they appeared to have support from orthodox scientific principles.

9. In addition to the witnesses referred to in the preceding paragraph there were several other witnesses opposed to fluoridation who possessed some technical or scientific background. They included four medical practitioners, two retired dentists, and a university graduate in chemistry who had retired from his profession. We have given careful consideration to all this evidence.

10. We are satisfied that all points of view in this country have been properly expressed. To ensure that the distance of this country from large centres of population would not have the effect of preventing the opinions of various overseas observers from being properly considered, we have made extensive use of material published in various countries; and this is particularly the case in regard to the writings of a number of prominent opponents of fluoridation whose views were mentioned from time to time.

Part II

THE DENTAL HEALTH PROBLEM

CHAPTER 1: THE PREVALENCE OF DENTAL DECAY IN NEW ZEALAND

11. Gross dental decay and the use of artificial teeth are so common amongst persons born in New Zealand that this departure from a state of health is regarded by some persons almost as if it were a normal biological process. Almost all the evidence made available to us tends to underline the widespread incidence of the disease and indicates the existence of a serious problem in public health. In order to understand the magnitude of this problem, it is necessary to establish the facts in quantitative terms. This in turn will enable an assessment to be made of any proposal such as fluoridation which is aimed at alleviating the situation.

12. The requisite data appear in the evidence of Colonel J. F. Fuller, Director of Dental Services for the New Zealand Armed Forces and a member of the Dental Research Committee of the New Zealand Medical Research Council; of Dr G. N. Davies, Head of the Department of Preventive, Public Health, and Children's Dentistry at the University of Otago, and recently appointed to the Expert Advisory Panel on Dental Health of the World Health Organisation; of Mr T. G. Ludwig, Dental Research Officer; and of Dr E. B. Reilly. This evidence is endorsed by Professor J. P. Walsh, Director of the University of Otago Dental School and member of the Medical Research Council of New Zealand. These witnesses emphasised the deplorable incidence of dental decay in children, adolescents, and young adults and produced certain publications in elaboration of their opinions (Hewat, 1948; Fulton, 1951; Hewat, Eastcott & Bibby, 1952; Davies, 1953; Hewat & Eastcott, 1955; and Figure 1). An analysis of this evidence is included in the following paragraphs 13 to 17.

13. Decay of the *deciduous (or milk) teeth* begins at an early age. Forty-six per cent of children aged 2 years already have experienced dental decay which affects on the average 2.4 teeth per child. At the age of 7 years 94 per cent of children are affected, and on the average each child has 7.9 deciduous teeth recorded as decayed, filled, and extracted on account of decay (Tables 1 and 3).

14. The prevalence of decay in the *permanent teeth* of children and adolescents is even greater (Tables 2, 3, and 4). The first molar teeth erupt at about 6 years of age and the front permanent teeth at about 6 to 8 years. At the age of 7 years, within a year of the first permanent teeth erupting, 69 per cent of New Zealand children have one or more decayed permanent teeth, and the average number recorded as decayed, missing (on account of decay), and filled is 2 per child; at fourteen years of age 99 per cent of children have experienced decay of the permanent teeth, the average number of decayed, missing, and filled teeth being 10 per child. If clinical examination of the mouth is supplemented by X-ray

examination to reveal areas of decay which are inaccessible to the mirror and probe, the average number of decayed, missing, and filled permanent teeth per child is 3·8 at 7 years, 16·5 at 14 years, and 18·6 at 16 years of age. Although the rate of decay appears to be considerable in other countries, this rapid increase in the rate during adolescence may be peculiar to New Zealand.

15. The incidence of dental decay in males (aged 17 to 23 years) who are performing their compulsory military training has been studied in surveys conducted under the direction of Colonel Fuller. He has a unique opportunity for observing the effects of previous treatment, and the results of the first survey are given in Table 5. More recent results of combined clinical and X-ray examinations showed that about 99 per cent of the recruits had experienced dental decay and that on the average a recruit had 22 decayed, missing, and filled teeth. Of these 5 were missing, 6 had been filled, and 11 were decayed and needed filling or extraction. The number of untreated teeth in these totals must be regarded as a particularly unfortunate fact. The mouths of seven to ten per cent of these recruits were in such a state that it would have been necessary to extract all the remaining teeth before the men would have been fit for service overseas. In one group of 597 recruits 18 per cent were already wearing some form of denture and 11 per cent required the fitting of some form of denture.

16. The evidence in respect of young adult females is not extensive (Table 6), but the available figures show an incidence of dental decay that is certainly no lower.

17. The effects of such widespread dental decay are obvious in the adult population. For example, the recruits for K-Force represent an older age group and in examining 712 of these recruits Dr Reilly found that 40 per cent had lost, or were soon to lose, all their teeth. In a group of 284 women aged 16 to 40 years attending an ante-natal clinic, 24 per cent had full upper dentures and 9 per cent had some other type of denture. The average number of decayed, missing, and filled teeth per person was 19·9 in the 16–20 age group and 24·5 in the 36–40 age group; and the average number of extracted teeth per person was 6·8 in the younger and 20·0 in the older age group (Littlejohn, 1953). A survey of 1,566 New Zealanders aged 21 years and over showed that 72 per cent were using some type of denture; and no fewer than 22 per cent of New Zealand born persons aged 21–29 years wore full upper and lower dentures (Davies & Walsh, 1953).

18. These impressive facts, which are not contested, have convinced us that dental decay is a major public health problem and a matter for grave public concern.*

*The recognised measurement of dental decay in the *permanent* teeth of an individual is the sum of the number of teeth decayed (in need of treatment by filling or extraction), missing (extracted on account of decay), and filled (past decay). Irrespective of the number of decayed areas or fillings, a defective tooth is counted once only. The wisdom teeth are excluded from consideration. This score, expressed as a D M F rate per person, per 100 persons or per 100 teeth, is used in making comparison between populations and is readily subjected to statistical analysis. A similar score is used for the *deciduous* teeth. It is the sum of decayed, extracted (on account of decay), and filled deciduous teeth and is expressed as a d e f rate in the same way.

CHAPTER 2: SOME CONSEQUENCES OF DENTAL DECAY

19. Dental decay is the invasion and destruction of teeth by micro-organisms. Since the infection may spread to the tooth socket and jaw bones, to the soft tissues of the face and neck, and even further afield, dental decay is the cause of other kinds of ill health in certain cases. Professor Walsh, who is Dean of the Dental School at the University of Otago and who has both medical and dental qualifications, gave evidence explaining that these infections could cause the onset of various illnesses which he described. He remarked also upon the pain and discomfort which often attended dental decay, the effect it had on efficiency, and the psychological problems which affected some people following the loss of their teeth.

20. There are no statistics to indicate the importance of these secondary disorders from a public health point of view, but we are satisfied that they are matters which should not be overlooked in a consideration of the general question.

CHAPTER 3: NATURE OF DENTAL DECAY

21. Although the causes of dental decay are not fully understood and evaluated, there was general agreement amongst expert witnesses (Colonel Fuller, Dr Davies, Mr Ludwig, Professor Walsh, Professor J. L. Warren, Professor F. R. Shroff) that the initial damage to the surface enamel of a tooth is brought about largely by acids which are formed during microbial fermentation of food debris left in contact with the tooth. Foods containing sugar and starch are the chief sources of acidic fermentation in the mouth. When these foods are sticky and adhere to the teeth they are likely to cause greater dental decay. The damage to the enamel is never repaired by natural processes.

22. The same witnesses agreed that the most effective method of preventing dental decay is a modification of diet which reduces to a minimum the consumption of sweet, sticky foods, especially those containing refined carbohydrates like sugar and white flour (Davies 1955b; Lilienthal, Goldsworthy, Sullivan, & Cameron, 1953). The prevalence of dental decay can also be reduced by thorough cleansing of the mouth immediately after food. The witnesses did not discuss the possibility that genetic factors may influence susceptibility to dental decay.

23. The filling of teeth is, of course, not a means of preventing dental decay but an attempt to treat it. The steps at present being taken to combat the disease by preventive means, or by the treatment of it, will be considered in the following paragraphs 24 to 56.

CHAPTER 4: DENTAL HEALTH EDUCATION AND DENTAL TREATMENT

24. Evidence has been given of the efforts made to provide instruction and dental health education by three separate organisations. These are:

- (a) The National Dental Service;
- (b) The Health Education Committee of the Department of Health;
and
- (c) The Council on Dental Health Education of the New Zealand Dental Association.

The first two of these are independent units contained within the Department of Health, while the third is a body set up in 1949 and financed by the dental profession itself.

25. *The National Dental Service*—Dr J. B. Bibby, Director of the Division of Dental Hygiene, Department of Health, appeared before the Commission to explain the objects, policy, and organisation of the Division. The aim of public health dentistry is the prevention of dental disease on a community or national basis. To that end the Division has established a National Dental Service composed of the School Dental Service, staffed by school dental nurses, and the Adolescent Dental Service undertaken partly by salaried dental surgeons but, in the main, by private dental practitioners working on a fee-for-service plan under the Social Security (Dental Benefits) Regulations 1946. The School Dental Service treats primary and intermediate school children aged 5 to 13½ years and offers treatment to pre-school children aged 2½ to 5 years. At present, owing to a large increase in the child population, the dental practitioners are assuming temporary responsibility for the treatment of a proportion of the older primary-school children. The Adolescent Dental Service treats children aged 13½ to 16 years.

26. The treatment figures for the child and adolescent population were as follows at 31 March 1956:

Total number of pre-school children aged 2½ to 5 years . . . . .	.....	127,800
Treated at school dental clinics	47,555	
Not receiving treatment	80,245	
	<hr/>	127,800
	<hr/>	
Total number of primary and intermediate school children aged 5 to 13½ years . . . . .	.....	378,500
Treated by school dental nurses and dental officers	246,897	
Treated by private dental practitioners as social security patients	96,938	
Not receiving treatment	34,665	
	<hr/>	378,500
	<hr/>	
Total number of adolescent children aged 13½ to 16 years . . . . .	.....	95,200
Treated by private dental practitioners as social security patients	75,441	
Not receiving treatment	19,759	
	<hr/>	95,200
	<hr/>	
Total number of children aged 2½ to 16 years . . . . .	.....	601,500

(NOTE—In this table it appears that the figures for numbers of children treated are taken from accurate records, whereas the figures for the child population, grouped according to age, are estimates to the nearest hundred calculated from census figures. The figures for children not receiving treatment, obtained by difference, are estimates having the same order of accuracy as the estimates of population.)

27. The cost of the National Dental Service for the year ended 31 March 1956 was £1,505,996 exclusive of capital expenditure. It is estimated that the number of children aged 2½ to 16 years will be about 712,000 by 1966. If the proportion of children now receiving treatment is unaltered and all other factors remain constant, the cost of the National Dental Service would be not less than £1,830,000 by 1966.

28. Concerning its aims, Dr Bibby said:

The immediate aim of the National Dental Service is to ensure a satisfactory standard of dental health as a contribution towards good general health for all children up to 16 years of age. There is provision under the Social Security (Dental Benefits) Regulations for extension of dental care up to 19 years of age.

29. At present the dominant activity working towards this objective is the provision of free examination and treatment at regular intervals for about 90 per cent of the school children and about one-third of the pre-school children. Dr Bibby stated that health education is an integral part of the work of the National Dental Service. Educational booklets, pamphlets, folders, and reprints of newspaper advertisements have been distributed to parents and children according to a carefully planned pattern at an average rate of more than 589,000 items for each of the years 1952 to 1956 inclusive. The material is prepared by the Departmental Health Education Committee (see para. 33). In the year ended 31 March 1956 school dental nurses gave 3,027 lectures and addresses to children and parents, and 244 health exhibits and stalls were organised for public functions. School dental nurses spent 36,488 hours in classroom and chairside instruction of children in the care of the teeth.

30. Since the educational work of the Dental Hygiene Division is closely woven into the whole organisation, and no separate vote is made for this activity, it is difficult to estimate the annual expenditure on dental health education. If all administrative and overhead charges are excluded, along with the maintenance of publicity apparatus and the salaries of those handling it, the cost is not less than £28,800 per annum.

31. The evidence of Dr Davies also contained reference to the availability and coverage of dental treatment (Table 7). At 31 March 1955 there were 728 dentists in private practice and 612 school dental nurses. The estimated population aged 5 and under 16 years for the year ended 31 March 1955 was 588,000. Forty-nine per cent of these children were under the care of school dental nurses, 37 per cent were enrolled for regular treatment by dental practitioners under the social security dental benefits scheme, 3 per cent were treated by dental officers attached to adolescent dental clinics, and 11 per cent received no treatment or were treated privately. In the same year the estimated population aged 2 and under 3 years was 150,000. Thirty per cent of these pre-school children were treated by the school dental nurses and the remainder received no treatment or were treated privately. Several dental witnesses referred to the heavy burden carried by the dental practitioners, who devote a large proportion of their time to the treatment of children under 16 years of age and still endeavour to provide complete dental attention for the whole adult population. The figures supplied by Dr Davies suggest that the dental practitioners have the responsibility for about 200,000 children, together with the rest of the population over 16 years, which cannot be less than 1,300,000.

32. *Health Education Committee of the Department of Health*—This committee provides instruction for children and parents and for the general public in the practice of oral hygiene and the prevention of dental disease through improvement of dietary habits.

33. The role of the Health Department in guiding the public towards better dental health is described in the evidence of Dr H. B. Turbott, Deputy Director-General of Health and chairman of the Departmental Health Education Committee. Emphasis has been placed on diets for expectant mothers, infants, and children and on oral hygiene and dental care. The Health Education Committee constantly reviews the choice of media for health propaganda and uses all forms of publicity, including printed matter, posters, health exhibitions, radio talks, and films. Since 1940 the health propaganda has been organised on a national basis, but from its inception in 1920 the Dental Hygiene Division has always regarded dental health education as an obligatory part of its work. Prior to 1940 the educational programme was carried out by field officers of the Division on a local basis.

34. *The Council on Dental Health Education*—Mr W. R. Hamilton, chairman of this body, informed the Commission that his council was inaugurated in 1949 as a committee of the New Zealand Dental Association. The objects of the council are to educate the public in matters of dental health, to assist dentists in furthering their professional knowledge, and to encourage dental research. To provide funds for the council, the New Zealand Dental Association has increased the annual subscription of each member by £3. The council has published pamphlets and wall charts dealing with the prevention of dental disease. In 1955, 26,000 pamphlets were purchased by dentists for chairside distribution. The cost of this material was additional to the annual levy of £3.

35. In reviewing the evidence of Dr Bibby and Dr Davies on the measures taken to combat dental decay, we have been deeply impressed by the extent to which the National Dental Service provides treatment for a very large proportion of the child and adolescent population and agree with Dr Davies that in this respect New Zealand appears to compare more than favourably with other countries. We are satisfied that the Division of Dental Hygiene, assisted by the Departmental Health Education Committee, has made long and sustained efforts to persuade the people to adopt dietary habits which are known to prevent dental disease. More recently the New Zealand Dental Association has inaugurated an educational programme at the expense of its own members, and this voluntary effort on the part of the profession is to be commended. In our view there is no evidence that dental health education has been overlooked or neglected. The effectiveness of these efforts is, however, another question.

CHAPTER 5: THE EFFECTIVENESS OF DENTAL HEALTH EDUCATION

36. No witness suggested that the effort made to date in this country to improve the dental health of the population by any of the methods of education already tried had achieved any really significant measure of success; nor did any witness suggest the adoption of any type of education which is not already being used. There was a considerable

volume of evidence, however, which was designed to show that a greater effort in this direction would, by itself, achieve satisfactory results. This view is not accepted by those who support fluoridation.

37. The only satisfactory evidence of the beneficial results of an education programme was provided by Dr Bibby. Basing his opinion on clinical observations alone he said that there had been an improvement in the condition of deciduous teeth of children under school age over a period of twenty-five years. He attributed this result to the advice received by expectant mothers on the need for correct diet, both for themselves and for young children, and to the greater attention parents have devoted to the oral hygiene of their children.

38. He compared the results of two surveys made on 5-year-old children presenting themselves for initial examination at the School for Dental Nurses, Wellington. In 1930-32 only 0.76 per cent of these children had teeth free from dental decay and 57 per cent of all the deciduous teeth were decayed, extracted, or filled, with an average of 11.2 affected teeth per child; but in 1948-50, 12 per cent of the children were free from dental decay and 37 per cent of all teeth were affected with an average of 7.1 affected teeth per child. Returns from school clinics throughout New Zealand recording the initial examination of 10,984 children between the ages of 5 and 6 years who attended a school dental clinic for the first time in 1955, showed that 14.5 per cent of the children had all teeth (deciduous and permanent) free from decay and that the average number of decayed, missing, and filled teeth was 6.6 per child.

39. No statistics referring to the teeth of older children attending at school dental clinics were presented and Dr Bibby was doubtful of any improvement in the condition of their permanent teeth.

40. It is difficult to assess accurately the extent of the improvement in the pre-school children because in the earliest group only deciduous teeth appear to have been counted while in the later groups all teeth, deciduous and permanent, are included. It is possible, too, that an increasing general standard of living between 1930 and 1950 (during which time the greater part of the improvement occurred), or some other factor, has had a beneficial effect on the results. But we think it unnecessary for the present purpose to decide these questions and are prepared to assume that the health education programme has been largely responsible.

41. So far as children of school age are concerned, we are quite certain that if there had been any significant reduction in the prevalence of dental decay Dr Bibby would have been aware of it. There is no other evidence on this point and we are satisfied that efforts of persuasion have so far failed to produce any worth-while result.

CHAPTER 6: THE POSSIBILITIES OF DENTAL HEALTH EDUCATION

42. Witnesses opposed to fluoridation have criticised the efforts of the Health Department and the dental profession to educate the public on the ground either that this matter had been neglected or was inadequate. We have stated in paragraph 35 that we consider there has been no neglect of dental health education. Nevertheless, many witnesses

believed that proper education pursued with sufficient vigour would persuade most of the people to eat the right foods and take other necessary steps to avoid dental decay. Mrs Stroobant put this viewpoint plainly:

With the right persuasion and appeal to their pride the majority of people could be guided into right eating habits.

Similar views were expressed by Mr Hannah, Mr Vogtherr, Mr Robinson, Mr Grove, Mr McMillan, Mrs Cope, and many others. In general terms, these witnesses who opposed fluoridation considered that an expanded and more vigorously conducted programme of dental health education would be sufficient to control the disease and, for this reason, fluoridation was unnecessary.

43. Several expert witnesses advocating fluoridation agreed that modern dietary habits involving the excessive consumption of refined carbohydrates were an important cause of dental decay and that it would be most desirable to augment the existing programme for dental health education whether fluoridation of public water supplies is accepted or not because the beneficial effects of improved diet and fluoridation would be additive.

44. Having said this, the supporters of fluoridation then contended that it is difficult to inculcate the habit of practising oral hygiene efficiently and quite unrealistic to suggest that any substantial change could be brought about in the dietary habits of a nation. Mr Swinburn, speaking on behalf of the Auckland Branch of the New Zealand Dental Association, said that preventive principles had been widely advocated by the practising dental profession and the School Dental Service for many years, but the response of the community had been inadequate. His association considered:

that there are no grounds for anticipating that the established manners and customs of the community could be amended by health education to the extent required for effective control of dental caries.

Although Mr R. B. Cape Williamson, a retired dentist, was opposed to fluoridation, he expressed a rather similar view.

45. The suggestion that preventive measures had been neglected was refuted by Professor Walsh, who stated that the dental profession had been striving for many years to educate the people to change their dietary habits and practice oral hygiene, measures which depend on the co-operation of the individual. Since too few individuals have co-operated effectively, the effort has failed from a community point of view. Under cross-examination Professor Walsh stated it as his opinion that the School Dental Service had made a tremendous effort in preventive dentistry.

46. After describing the function of the National Dental Service and the results achieved by it (see paras. 37 to 41) Dr Bibby made a significant statement. He said:

I am sure it is widely known that dental decay can be reduced by attention to oral hygiene and less frequent consumption of carbohydrate and sugary foods, but against this knowledge are set the accepted social customs and the dietary habits of the nation – difficult to change even over a long-term period.

The young child in the home may be taught to observe all the tenets of good oral hygiene and his diet may be easily controlled, but once his social contacts and experience widen outside the home it is difficult for him to flout the social and dietary habits of his companions.

I am forced to the conclusion that under the present economic and social conditions in New Zealand, fluoridation of public water supplies as a supplement to other dental health measures provides the only real hope of achieving the ultimate aim of public health dentistry, that is, the prevention of dental disease on a national basis.

47. Several of the dental witnesses advocating fluoridation anticipated that the improvement in dental health which they stated would result from this measure would give the people a reasonable hope of preserving their teeth and be conducive to better standards of diet and oral hygiene. Other witnesses have suggested that the people would rely on this measure and become more careless in other respects.

48. In regard to these various questions, it will be seen that supporters and opponents of fluoridation are agreed on the causes of dental decay and on the importance of correct diet in preventing the disease. In addition, most witnesses would like to see an intensification of the programme for dental health education. However, the opponents of fluoridation would rely *solely* on an educational programme to reduce the prevalence of dental decay. On this question we are satisfied that at the present time there is no hope of such a programme achieving a significant beneficial effect.

CHAPTER 7: THE EFFECTIVENESS OF TREATMENT OF DENTAL DECAY

49. We have considered the effectiveness of measures designed to prevent dental decay by means of health education; it becomes necessary to turn to its treatment. There is no doubt that conservative treatment can save permanent teeth or postpone the loss of them, but the evidence of Colonel Fuller and Dr Davies shows that treatment alone does not stem the advance of dental decay in New Zealand. For instance, a survey of military recruits aged 18 to 21 years demonstrated that the incidence of dental decay in those who had received regular treatment by school dental nurses and by dentists during childhood was not significantly different from that found in recruits who had received no regular treatment. The difference was that those who received no treatment had lost more teeth or required more extractions (Figure 2).

50. The problem which faces the dentist when he attempts to keep pace with the attack rate of dental decay is illustrated by some observations on a group of 304 senior high-school pupils and university students, amongst whom the average number of tooth *surfaces* affected by untreated dental decay was 12.6 per person at the initial examination. A year later each person had developed an average of 6.6 newly decayed tooth surfaces and the available dental service was unable to treat more than an average of 4.9 tooth surfaces per person. In consequence, the average number of tooth surfaces in need of treatment increased from 12.6 to 14.3 per person in one year in spite of the effort to control the disease (Davies & King, 1951).

51. For the reason set out in the preceding paragraph, Dr Davies stated that there are too few dentists and dental nurses in New Zealand to cope with the fillings and extractions that are needed if a rapid attack

rate of this order is to be met by treatment. Several other expert witnesses expressed the same opinion, amongst them Professor Walsh, who said:

New Zealand teeth are decaying faster than the dental profession, even with the aid of the school dental nurses, can cope with them. At the present time we simply cannot recruit and train enough persons to deal with this one disease.

52. Commenting on the measures taken to control dental decay, Dr J. L. Warren, Professor of Conservative Dentistry at the University of Otago Dental School, made this succinct and telling statement:

The present system of controlling dental caries in New Zealand is the placement of fillings in teeth as they decay. This system is wasteful. Firstly, *in the absence of good hygiene or good diet*, and they are both commonly absent, fillings do not in fact control the incidence of dental caries. The destruction of the teeth is progressive and complete despite fillings. Second, only 60 per cent of children and adolescents whose teeth are filled at the State's expense continue with treatment when the State relinquishes its responsibility, that is, after the sixteenth birthday.

53. No evidence has been brought forward to question the views on this matter of Colonel Fuller, Dr Davies, Professor Walsh, Professor Warren, and representatives of the dental profession throughout the country. We have no hesitation in accepting their assurances that treatment alone does not control dental decay and that the problem is beyond the present resources of the dental profession.

54. Professor Warren, Dr Watt, and many other dental witnesses have pointed out that constant pressure on all dentists to fill decayed teeth has a bad effect on dentistry in other directions. These witnesses consider that, because most dentists spend such a disproportionate amount of time filling teeth for children and adolescents, they are not as skilled as they could be in the procedures used for treatment of common disorders such as malocclusion (crooked teeth) and diseases of the gums, which affect a substantial part of both the child and adult population. We agree with Professor Warren that:

dentistry can serve the public interest best only if the prevalence of dental decay in children and adolescents can be reduced.

55. The great difficulty of providing an adequate dental service for an increasing population in the Auckland urban area is well illustrated by the evidence of Mr P. F. Swinburn, who gave evidence on behalf of the Auckland Branch of the New Zealand Dental Association. The total population is 381,000. The children attending schools number 85,800, of whom 45,000 are enrolled with the School Dental Service and 35,000 with the dental practitioner service under the social security dental benefits scheme. The ratio of practising dentists to the children served by them is 1 to 250; but the ratio of practising dentists to the population served (i.e., the total population minus the group treated by the School Dental Service) is 1 to 2,400. In this community more than 80 per cent of pre-school children develop dental decay and the average child requires treatment for at least seven areas of decay before reaching school age. Subsequently, treatment is needed for an average number of six decay areas per annum throughout childhood and adolescence. At the attainment of the school-leaving age more than 99 per cent have experienced dental decay and many have lost teeth as a result of advanced decay.

56. The Auckland Branch of the New Zealand Dental Association considers that the combined resources of the School Dental Service and the practising dental profession will not be adequate to cope with all the

dental problems of Auckland's increasing population unless some measure can be applied effectively to reduce the prevalence of dental decay to manageable proportions. There is a similar picture in the urban areas of Dunedin, Christchurch, and Wellington (evidence of Mr J. R. Benson, Dr E. B. Reilly, and Dr D. G. Watt).

CHAPTER 8: CONCLUSIONS IN REGARD TO THE DENTAL HEALTH PROBLEM

57. We regard the following matters as established:

- (1) Virtually every child born in New Zealand experiences dental decay and in consequence an unduly high proportion of the population over the age of 21 years uses some form of denture.
- (2) Sustained efforts over many years by both the Department of Health and the dental profession to introduce improved dietary habits have been ineffective. At the present time there is no hope of any programme of dental health education achieving a significant beneficial effect.
- (3) The filling of teeth is not a preventive measure but a means of treating decay.
- (4) The problem of controlling the rate of dental decay by treatment is beyond the resources of the dental services in this country.
- (5) The incidence of dental decay in New Zealand is so widespread and severe that it constitutes a major problem in public health and is a matter for grave concern.

Part III

FLUORIDE IN RELATION TO DENTAL HEALTH

CHAPTER 9: NATURAL OCCURRENCE OF FLUORINE

58. The element fluorine is always in a combined state in nature, and in this state it is to be found almost everywhere in the earth's crust. It is a constituent of certain minerals found in rocks and soil; and small amounts occur in most natural waters in the form of soluble fluoride ions. Small quantities are present in nearly all foods and in the human body where the fluoride is concentrated significantly in bones and teeth.

59. The fluoride naturally present in waters is derived from the solution of a wide range of minerals. In considering this fact, Dr W. S. Fyfe, Senior Lecturer in Inorganic Chemistry at the University of Otago, raised the question:

Does a synthetic chemical such as sodium fluoride, when added to natural water, function in a different manner from the natural fluoride present in drinking water?

Dr Fyfe answered this question as follows:

In all these solid compounds (fluorite which is calcium fluoride, apatites, micas, and amphiboles) and in sodium fluoride, the fluorine exists as discrete particles called ions which have a closely fixed size, shape, and electrical charge. When all these substances dissolve in water, at low concentrations, the fluoride ions pass into solution and exist in the solution as separate entities with properties completely independent of the salt from which they were derived. Thus the fluoride ions in a solution of calcium fluoride or of sodium fluoride are identical and will do exactly the same things in a chemical or biochemical sense.

60. This statement, which is supported by the evidence of Mr L. H. James, Assistant Director of the Dominion Laboratory, of Colonel Fuller, and Dr Muriel Bell, is considered by us to be the true description of fluoride ions and their behaviour. We refer to the matter in more detail in Chapter 20.

CHAPTER 10: HISTORICAL BACKGROUND

61. One of the first to perceive a relation between dietary fluoride, the enamel of human teeth, and dental decay was Sir James Crichton-Browne (1892), as pointed out in the evidence of Mr McCombs. The latter also mentioned the antecedent experimental work of Dr Erhardt (1874) on fluoride in dogs' teeth. The historical background to fluoridation is described in the evidence of Colonel Fuller, Dr Davies, Mr McCombs, and others supporting fluoridation; and the discovery of the relationship between fluoride and dental disease has been well told in publications by Dean (1946) and by Fuller (1956).

62. A defective formation of tooth enamel, "mottled enamel", had been known in various parts of the world for a very long time. The "mottled enamel", which is characteristic of certain localities in the United States of America was ultimately recognised to be due to the use of domestic water supplies containing an excess of fluoride. It was also observed that dental decay was *less* prevalent in districts where this

type of "mottled enamel" occurred. Similar observations were made in England. (See Black & McKay, 1916; McKay, 1929; Churchill, 1931; Smith & Smith, 1932; Ainsworth, 1933; Elvove, 1933; Weaver, 1944.) Dr Muriel Bell submitted a recent paper (Berry (1957) unpublished) which correlates the incidence of dental decay and mottling of enamel in parts of Great Britain where the water contains from 0.1 to 5.8 ppm of fluoride. This confirms the earlier observations.

63. In different regions of the United States the concentration of fluoride varies from less than 0.05 to 14 ppm of fluoride. Careful assessments of the prevalence of dental decay in a number of American cities established an inverse relationship between dental decay and the fluoride content of the water supplies: a high incidence of dental decay was associated with a low concentration of fluoride in the water and *vice versa*, particularly in the range 0.1 to 1.0 ppm of fluoride (Dean 1946).

64. An important objective of research workers in the United States Public Health Service was to discover the precise concentration of fluoride in a domestic water supply which would give maximum protection against dental decay without causing "mottled enamel". "Mottled enamel" can develop only in the first 8 years of life, while the enamel is being calcified, but it persists throughout life. This condition is not severe unless children are brought up in a region where the concentration of fluoride in the water supply exceeds 1.9 ppm. Very mild mottling, detectable only by close expert examination, may be expected in 6 to 10 per cent of children when the fluoride content of the water is 1 ppm. An analysis of the prevalence of dental decay in cities with water supplies containing a range of fluoride concentration from 0 to 2.6 ppm showed that there was little extra benefit to dental health when the concentration exceeded 1 ppm. Since there is no disfigurement of teeth at this concentration, 1 ppm was selected as a suitable level for the fluoride content of public water supplies (Dean, 1946).

65. From such considerations it was deduced that the fluoride content of public water supplies should be adjusted in the interests of dental health according to clearly defined principles: (1) where the fluoride concentration of the natural water *exceeds* 1 ppm it should be reduced to this figure by removal of fluoride for the purpose of preventing "mottled enamel"; (2) where the natural concentration is already 1 ppm no adjustment is needed; and (3) where the natural concentration is *less* than 1 ppm it should be raised to this figure by addition of fluoride for the purpose of preventing dental decay (Dean, 1946).*

66. The evidence in favour of this procedure was strong, but the United States Public Health Service decided to conduct carefully planned, long-term investigations in selected cities; and a 10-year investigation of the same kind was initiated in Canada by the City Health Department of Brantford, Ontario.

*The following may help to give an impression of the amount of fluoride in water containing 1 ppm: A household-measuring teaspoon quarter filled with sodium fluoride powder would contain the quantity which must be dissolved in 110 gallons of fluoride-free water to give a fluoride concentration of 1 ppm. The weight of fluoride is slightly less than half the weight of the sodium fluoride. Further, it may be noted that 1 milligram of fluoride ion in 1 litre of water gives the concentration of 1 ppm.

67. In New York State the communities selected were Newburgh and Kingston, located 35 miles apart on the Hudson River, each with a population of about 30,000 and each using a water supply with a low fluoride content. In 1945 the water supply of Newburgh was treated with sodium fluoride to raise the fluoride content to 1.0 to 1.2 ppm, but the fluoride content of the Kingston supply was not altered.

68. The Michigan study utilised three cities of comparable size – Muskegon, Aurora, and Grand Rapids – in which the respective water supplies contained 0.2, 1.2, and 0.2 ppm of fluoride. The fluoride content of the water supply at Grand Rapids was raised to 1 ppm in 1945. By 1951 the people of Muskegon were so impressed with the beneficial effects of fluoridation at Grand Rapids that they terminated their part as “control” city and the fluoride content of their water supply was raised to the optimum level. Several other less elaborate studies are in progress in different States.

69. The Canadian study was designed on the same principle to compare a “control” water supply (Sarnia, very low fluoride), a naturally fluoridated water supply (Stratford, 1.2 ppm), and an artificially fluoridated water supply (Brantford, 0.1 ppm, raised to 1.2 ppm in 1945).

70. All these investigations were designed and executed with great thoroughness. The results of 10 years of study at Newburgh-Kingston, at Grand Rapids - Aurora - Muskegon and at Brantford-Sarnia-Stratford (Ast, Smith, Wachs, & Cantwell, 1956; Arnold, 1956; Brown, 1955) demonstrate beyond doubt that artificial fluoridation of the water supply brings about a striking reduction in the prevalence of dental decay. Five years after the commencement, the trend of the results was apparent, and in 1953 the Surgeon-General of the United States approved fluoridation as a public health measure. Some of these results are set out in Chapter 12.

CHAPTER 11: THE MODE OF ACTION OF FLUORIDE IN PREVENTING DENTAL DECAY

71. Witnesses supporting fluoridation (Mr Ludwig, Dr Muriel Bell, Professor Shroff, and Dr Davies) have brought forward evidence to explain the role of fluoride in tooth structure. During the development of teeth small amounts of fluoride are incorporated into the crystalline structure of the mineral salts (apatites) deposited throughout the hard substance of the teeth. The fluoride present in food and drinking water is conveyed to the site of development by the blood stream. The mineralisation of the deciduous teeth begins 3 to 4 months before birth; that of the permanent teeth commences at birth in the first molars and at later periods in the other teeth. Calcification of the enamel is completed at 2 to 3 years in the first molars (erupting at 6 years), at 7 to 8 years in the second molars (erupting at 12 years), and at 12 to 16 years in the wisdom teeth. The distribution of fluoride in various parts of the teeth has been studied in detail (Brudevold, Gardner, & Smith, 1956).

72. After the teeth have erupted and made direct contact with the fluoride that is present in food and drinking water, fluoride is added to the surface layers of enamel but not to the deeper parts of the teeth. Analyses show that the fluoride concentration is highest in the outermost layers of the enamel (Table 8).

73. Since no diet adequate for continued existence is free from fluoride, all teeth contain fluoride. When the human subject has been exposed to a domestic water supply containing 1 ppm of fluoride or more during the whole period of tooth formation and eruption, the fluoride content of the teeth is substantially greater than it is when the fluoride content of the water is low (McClure & Likins, 1951; see also Table 8).

74. It is believed that the incorporation of fluoride into the mineral structure of the tooth makes the enamel harder and more resistant to dissolution by the acids formed in carbohydrate fermentation, and, therefore, more resistant to dental decay. There is experimental evidence in favour of this view which is also consistent with predictions made from chemical theory (evidence of Dr Fyfe). Enamel taken from the deciduous teeth of children who had been exposed since birth to water containing 1.2 ppm of fluoride was less soluble in acid than that from the teeth of children exposed to a non-fluoridated water supply (Finn & De Marco, 1956). It has also been shown that the degree to which the enamel of both deciduous and permanent teeth dissolves in acids is inversely proportional to the fluoride content (Isaac, 1956). This author believes that the beneficial effect of fluoridation depends on the accumulation of sufficient fluoride in the outermost part of the enamel.

75. Maximum benefit is likely to be obtained only when the individual receives sufficient fluoride throughout the period of calcification of the teeth and continues to receive an amount which increases the fluoride content of the surface enamel after the teeth have erupted. The child born and brought up to maturity in a fluoridated region receives this benefit, and good effects may continue in adult life.

76. The opponents of fluoridation have not challenged this evidence directly; but in a prepared statement (the *Hastings Address*) Dr Eva Hill asserts that there are many places in the world where the inhabitants have perfect teeth although there is no fluoride in the soil or drinking water, and gives Samoa as an example. The context shows clearly that Dr Hill meant to imply that there is no fluoride in the teeth of Samoans. Under cross-examination by Mr Woodhouse, Dr Hill accepted the analyses of Harrison (1949a) which demonstrate that in fact the teeth of Samoans do contain fluoride. The same point was raised by Mr Jordan in cross-examination of Dr Davies and answered by reference to Harrison (1949a). Quoting again from the *Hastings Address*, Mr Jordan mentioned (without reference to the publication) a report by Professor R. S. Harris, Massachusetts Institute of Technology, to the effect that fluoride is not a component of many sound teeth. Dr Davies expressed the view that no tooth is completely devoid of fluoride, and his opinion agrees with the statement of the United Kingdom Mission on Fluoridation (1953) that "the enamel and dentine of all teeth contain fluoride".

77. We are satisfied that none of the theories advanced in regard to this matter invalidates the hypothesis that fluoride is a necessary component of tooth structure required to harden the enamel and increase its resistance to attack by acids. Before leaving the subject, we note the fact that several witnesses opposed to fluoridation for one reason or another, agreed that fluoride was beneficial to teeth.

CHAPTER 12: EFFECTIVENESS OF FLUORIDE IN REDUCING THE PREVALENCE OF DENTAL DECAY

78. The evidence of Colonel Fuller and Dr Davies contains detailed statistics intended to prove the effectiveness of fluoridation. The efficacy of fluoride in preventing dental decay is illustrated by the observations of Arnold (1943) who compared the prevalence of dental decay in children aged 12 to 14 years living at Aurora, where the water supply contains 1·2 ppm of *natural* fluoride, with that in children of the same age living at Waukegan and Oak Park where the water contains no fluoride (cities in Michigan, U.S.A.). At Aurora 23·5 per cent of the children had no dental decay, and this is to be contrasted with 3·1 per cent at Waukegan and 4·3 per cent at Oak Park. The number of decayed, missing, and filled teeth per child was 2·81 at Aurora, 8·10 at Waukegan, and 7·22 at Oak Park, representing a reduction of approximately 60 per cent in favour of Aurora. At Aurora there was a reduction of 75 per cent in the number of first molar teeth extracted on account of decay, and approximately 95 per cent reduction in the number of front upper teeth with decay between them.

79. The beneficial effects of fluoride are not confined to children. Figure 3 shows the results of comparing two adult populations aged 20 to 44 years (Russell & Elvove, 1951). One group consisted of 155 persons who had resided all their lives in Boulder (Colorado) where the water supply contains no fluoride; the other group of 385 persons were native to Colorado Springs where the water supply contains 2·5 ppm of fluoride. The residents of Colorado Springs had about 60 per cent fewer decayed, missing, and filled teeth and the benefit persisted into middle age. The numbers examined in the middle-aged group were small, but the difference is significant statistically.

80. To contrast the position with that obtaining in New Zealand, Colonel Fuller pointed out that about one-third of the persons aged 20 to 23 living in a high-fluoride area in the United States are free of dental decay whereas only 1 to 2 per cent of his military trainees in the same age group are free of dental decay.

81. In England surveys have been made in three high-fluoride districts – South Shields, Colchester, and Slough (0·82 to 1·45 ppm of fluoride) and in three low-fluoride areas – North Shields, Ipswich, and Reading (0·07 to 0·3 ppm of fluoride). These surveys were limited to women aged 21 to 45 who were native to the district and attending ante-natal and child welfare clinics (United Kingdom Mission Report, 1953). The assessment of dental decay based on the average number of decayed, missing, and filled teeth per person shows a beneficial effect of fluoride similar to that observed in the United States.

82. The *addition* of fluoride to a water supply which is naturally deficient in this substance ultimately produces beneficial effects on the prevalence of dental decay in both deciduous and permanent teeth of children. This is demonstrated by the published results of 10 years of investigation at Newburgh, Brantford, and Grand Rapids (Tables 9 to 13 inclusive) where the water supplies have been artificially fluoridated. After 10 years of fluoridation in Newburgh, 26 per cent of the children aged 6 to 8 years are free from dental decay; in New Zealand only 2 to 3 per cent of the children in this age group are free of decay. Figures 4 and 5, referring to the cities of Grand Rapids and Aurora, show that

artificial fluoridation of the water supply at Grand Rapids has reduced the incidence of dental decay to the greatest extent in children born after fluoridation began or shortly beforehand, but the older children whose permanent teeth were in an advanced stage of calcification when fluoridation commenced, have also acquired a distinct benefit. The curves show how the incidence of dental decay amongst the children of Grand Rapids has decreased until in the younger age group it has equalled, and in the older age groups approached, the level characteristic of the Aurora children who consume water containing 1.2 ppm of natural fluoride.

83. These results indicate there is no difference between the beneficial effects of natural and artificial fluoridation. The Newburgh-Kingston study differs in so far as the effects of an artificially fluoridated water supply (Newburgh) are compared with those of a low-fluoride water supply (Kingston), but the results give an equally convincing demonstration of the decrease in dental decay brought about by fluoridation (Table 13).

84. The Canadian investigation at Brantford, Sarnia, and Stratford is the most complete of the 10-year North American studies, since it combines the features used at Grand Rapids - Aurora with those employed at Newburgh-Kingston. The pattern of the results is the same (Tables 11 and 12). The summary of a subsequent report by the Dental Health Division, Province of Ontario, published by authority of the Minister, is an arresting statement:

A fact of fundamental importance in public health has been established. Raising the fluoride content of a fluoride-deficient water supply to about 1 part per million will lower the attack rate of tooth decay, among children born subsequent to fluoridation, to about one-third of that which prevails among those born and continuing to reside in communities which have no fluoride in their water supply, such as Sarnia. For every three decayed teeth they would have had, they have only one. Moreover, in this one there is very much less decay and it progresses much more slowly than in the average tooth where there is no fluoride, as these teeth resist and delay the progress of decay. This makes treatment of the residual decay easier for both the patient and the dentist, reduces the need of very young children for extensive dental treatment, and aids in preventing the premature loss of teeth. This loss is the chief cause of irregular permanent teeth.

85. An identical pattern has emerged from studies at Evanston (Illinois), Marshall (Texas), and Sheboygan (Wisconsin) and other places. The Evanston results after 8 years of fluoridation have been published by Hill, Blayney, & Wolf (1956). Mr Ludwig stated that of twenty full-scale studies in the United States, none failed to show a remarkable reduction in the incidence of dental decay.

86. Dr G. N. Davies has had the advantage of conducting an independent examination of school children at both Newburgh and Kingston (Tables 14 and 15). From these results and from his studies of all the research that has been done in North America, Dr Davies concludes that:

(a) Fluoride added to water supplies by mechanical means exerts the same beneficial effect in reducing the prevalence of dental decay as does fluoride when it occurs naturally in water. (Compare Grand Rapids 1954 with Aurora, and Brantford with Stratford.)

(b) Permanent teeth are protected to a greater extent than deciduous teeth.

(c) Children born after fluoridation has been instituted are protected to a greater extent than children born prior to fluoridation.

(d) The beneficial effects of fluoridated water are not confined to persons drinking the water since birth. The fact that a reduction of dental decay was observed for teeth which were fully formed when fluoridation began indicates

that a beneficial effect is also gained by older age groups. (This effect is seen in the teeth of the 16-year-old children at Grand Rapids. The incidence of dental decay in 16-year-old children in 1954 is lower than it was in 1944, but it is not yet as low as the incidence in Aurora.)

(e) At the age of 6 to 8 years, when the prevalence of dental decay in the deciduous teeth is highest, the prevalence rate is reduced by 42 to 54 per cent by fluoridation.

(f) In children born after fluoridation began, the prevalence of dental decay in permanent teeth is reduced by 52 to 75 per cent.

87. In (f) Dr Davies refers to the range of reduction in different age groups. An independent assessment of the facts appears in the summary and conclusions of the report of the United Kingdom Mission (1953):

Epidemiological studies in America have demonstrated beyond doubt that among children and adults who have been born and brought up in areas where the drinking water contains fluoride at a level of 1 ppm or more, there is much less dental caries than in areas where the water is free from fluoride. Compared with areas where the drinking water contains little or no fluoride there is about 60 per cent less dental caries among children aged 12 to 14 years and about six times as many children have permanent teeth which are free from caries (18 to 29 per cent compared to about 4 per cent). A few studies among adults, both in England and in the United States show that the effect of fluoride persists at least up to about 40 years of age.

In recent years many North American communities whose water supplies contained little or no fluoride have added fluorine compounds to their water. In certain of these communities the dental effects of "fluoridation" have been studied carefully.

In our opinion the evidence is conclusive that among children in fluoridation areas there is a reduction in the incidence of dental caries to a level comparable with that experienced where fluoride occurs naturally in the water. To date, a reduction of this extent has been demonstrated only among children up to 6 years of age, because no fluoridation scheme has been in progress for more than 7 years. Data relating to older age groups are as yet insufficient to warrant firm conclusions.

There is nothing to suggest that a water containing fluoride, naturally derived, has properties different from those of a water to which fluoride has been added. At the concentration of fluoride used, about 1.0 ppm, it is the fluoride ion that is operative and the nature of the salt used is of secondary importance.

88. It will be noted that this report is outdated and that the good results in older children are known now. A more recent health reference note published in July 1955 by the United Kingdom Ministry of Health states:

The fluoride added is indistinguishable from the naturally occurring ion and is indeed prepared from the same minerals. It reduces the incidence of dental decay in children by about 60 per cent and it is anticipated that it will do so to a substantial extent in adults also.

CHAPTER 13: SOME CRITICISMS OF THE EFFECTIVENESS OF FLUORIDATION

89. The witnesses opposed to fluoridation have not advanced any evidence which could be regarded as a serious challenge to the figures and conclusions summarised above. Several witnesses have doubted the reliability of the statistics and some, including Dr Eva Hill and Mr C. E. Gamble, quoted the official report of Dr J. A. Forst (New York State Department of Education) on an inspection of school children in Newburgh and Kingston four years after the water supply of Newburgh was fluoridated. This report is often cited in anti-fluoridation literature to show that children in Newburgh had 63 per cent of dental defects as against 41 per cent in the children of Kingston, and 45 per cent more oral defects of all kinds. An explanation of the report was given by Colonel Fuller in response to Mr Dowling's cross-examination.

In Newburgh the examinations were conducted by a dental hygienist and each tooth cavity was counted: if there were ten cavities there were *ten* defects. In Kingston, however, the examinations were carried out by a nurse or by a doctor, and if a child had ten or any number of tooth cavities, this observation was recorded as *one* defect. The examination conducted by the Department of Education was a routine examination of school children and not intended to be a comparison of the prevalence of dental decay in the two cities. A letter written by Dr David B. Ast of the State of New York Health Department, covering a cyclostyled letter from Dr Forst, was tabled before the Commission. This letter establishes the manner in which the inspection was made and shows conclusively that the interpretation applied to Dr Forst's report by Dr Hill and other witnesses is erroneous.

90. It was suggested by Mr Cape Williamson, a retired dentist of Christchurch, that caution be exercised in considering expert evidence based largely on external reports favourable to fluoridation in other countries. He invited the Commission to consider a publication, *Fluoridation of Public Water Supplies*, by F. B. Exner, M.D. (1955), which is a report prepared for the city of New York at the request of Mr Arthur Ford, Commissioner of Water Supplies, Gas, and Electricity in that city. Dr Exner has taken a prominent part in opposing fluoridation in the United States of America, and his views have been referred to us on several occasions during the course of the inquiry. Accordingly, we have given this report detailed and careful study. In our view, it is open to criticism. We refer to a number of statements contained in it in the following paragraphs.

91. At page 33 Dr Exner attacks the use of the D M F rate in measuring the prevalence of dental decay. He writes:

In spite of the fact there can be no unit for measurement of tooth decay that means anything, and no way to apply it if there were, the Public Health Service invented one. It is called the D M F rate and consists of the combined sum of decayed, missing, and filled teeth per person, or per 100 people.

This argument depends upon the implication that the D M F figure is the sum of unlike things. Throughout the world, however, the figure is regarded as the sum of present and past decay. The count is a count of teeth, and each tooth is included if evidence can be seen of damage to it by decay. Teeth extracted because of decay necessarily are included. It is an internationally recognised method of recording and comparing the prevalence of dental decay in population groups and provides a standard of measurement which is easily attained without any marked variations by dentists everywhere. We would have thought that Dr Exner would know of these facts. In any event we are satisfied that his argument that the D M F figure is the sum of unlike things has no logical basis.

92. Following his criticism of the United States Health Department for its use of the D M F rate, Dr Exner expressed his approval of the incidence rate. This gives "the percentage of people who have or have had tooth decay as against the percentage who have not and never have had" tooth decay. It will be evident that in communities where virtually everybody is affected, the incidence rate will show the same high figure whatever might be the average number of teeth affected per person. Its value arises only in assessing the percentages of persons entirely free of dental disease. It is the case, however, that research

workers in the United States Public Health Service have periodically published this figure along with D M F rates. Dr Exner has failed to mention this fact. We regard the omission as unfortunate in the circumstances. It leaves Dr Exner himself open to the criticism that he has been somewhat discriminating in his choice of facts.

93. At page 35 Dr Exner implies that the United States Public Health Service has falsified the results of fluoridation studies. He writes:

All later studies have been designed, and their results so presented as to confirm this "hypothesis" and its figure of 67 per cent reduction. It has taken ingenuity at times, but as we saw in the previous study, they are quite up to it . . . There is this to be said for Dean and McKay and to a certain extent for McClure. They publish their actual findings in complete and meticulous detail. This was commendable, but it left them very vulnerable. No such mistake has been made at Newburgh or Grand Rapids. No statistician, and no one else outside the group of experimenters, have ever been able to make head or tail of what is behind their published figures.

Dr Exner appears to have devoted a great deal of study to the question of fluoridation and the statistical information which inevitably accompanies a discussion of its aims and possibilities. In the circumstances it is not easy to accept this colourful statement as a serious expression of his own understanding of the various findings.

94. Immediately below the statement referred to in the preceding paragraph appears the following:

Meanwhile, Blayney at Evanston, Illinois, was trying to run an honest and scientifically respectable experiment. He refused to be pressured into making premature or unfounded claims. His findings were quite different from the others and he said so. He was excoriated unmercifully at the Fourth Annual Conference in 1951 for being too honest. Since then we have heard nothing about there even being an experiment at Evanston.

In his final address, Mr Woodhouse referred to this extract in the following terms:

An examination of the position reveals that Dr Blayney joined in publishing the eleventh of a whole series of reports on the Evanston study in February 1955. This was within six months of Dr Exner's own paper (which was published in July 1955). The tenth of the series had been published in June 1952. I hesitate to say it, but these facts give rather an air of absurdity to Dr Exner's casual dismissal of what he calls "an experiment at Evanston".

I have already referred to the report published by Dr Blayney and others in September 1956. He may perhaps feel some satisfaction that while his reports have been ignored by Dr Exner, his efforts are regarded as honest.

We see no reason for disagreeing with the view expressed by Mr Woodhouse in regard to this matter.

95. There is a further reference to Dr Blayney at page 46. On this occasion Dr Exner spells his name as "Blaney". After remarking that only those who could be "depended upon to support the official viewpoint" were accepted by the United States Public Health Service as "competent investigators", Dr Exner writes:

Blaney of Evanston, and others who testified against fluoridation before the Delaney Committee, are obviously not competent investigators and have, by one means or another, been more or less effectively silenced.

Dr Blayney (University of Chicago) is the director of the Evanston study programme. On reading Dr Blayney's evidence given in 1952 before the Delaney Committee we find that, although as a cautious investigator he refused at that time to come to firm conclusions pre-

maturely, he did not testify against fluoridation. On the contrary, his attitude towards the process was favourable. In the circumstances Dr Exner's statement is misleading.

96. At page 2 appears the following statement:

... the Public Health Service expects that if water is fluoridated, some 15 to 20 per cent of children will have their teeth permanently disfigured by fluoride ..."

For this statement Dr Exner provides no reference or authority. Our own researches have failed to discover any evidence which supports this as being at any relevant time the view of the United States Public Health Service. On the contrary, the only evidence on this point indicates that the service expects no disfigurement when water is fluoridated at levels recommended by it. Some 6 to 10 per cent of children may develop barely noticeable white flecks in the enamel of their teeth, but this is regarded as of no aesthetic significance. Dr Exner's statements appear to misrepresent the attitude of the United States Public Health Service.

97. The matters to which we have drawn attention in the preceding paragraphs are not exceptional. There are numerous instances of a similar nature in the report, but it is not possible, nor is it necessary, to consider all of them here. In most instances a good deal of research is required to establish the real position and few of Dr Exner's readers would have access to the necessary material nor would they have the necessary technical qualifications. We consider the report as a whole to be lacking in objectivity, that it frequently fails to represent the real opinion of quoted authorities and that it is the work of a skilful propagandist. It has failed to satisfy us that the expert evidence to which we have referred earlier requires any qualification.

98. While conceding the beneficial effect of fluoride on the teeth of children, some witnesses opposed to fluoridation have contended that this process does no more than delay the occurrence of dental decay. In a sense this is true. For instance, at the age of 9 years a child in a fluoridated area (Aurora) will have 1+ decayed, missing, and filled permanent teeth while a child of the same age in a non-fluoridated area (Grand Rapids before fluoridation) will have four. At the age 15 the child at Aurora will have four decayed, missing, and filled teeth, the same as the Grand Rapids child aged 9. The opponents of fluoridation argue that the process has delayed decay by six years.

99. Commenting on this situation Colonel Fuller said:

At age 15, by which time the Aurora child has in fact developed four decayed, missing, and filled teeth, the child without fluoridation has thirteen decayed, missing, and filled teeth, and the point is that at any given age the child without fluoride has more than twice the amount of dental decay as compared with the child with fluoride ... But even disregarding the question of the benefits carrying over into adult life, it must surely be evident that the protection given to children in adolescence in itself would be an enormous contribution in this country; that it would take our children through that critical period of early adolescence when the attack rate of dental decay is so intense and carry them into young adult life. In our opinion, this statement of the position is undoubtedly correct.

100. We have examined the statistical evidence brought forward by the advocates of fluoridation, and the conclusions they have drawn from that material. We have also given careful consideration to the various criticisms advanced by their opponents both in verbal evidence and in exhibits, including the writings of Dr Exner, Mr K. K. Paluev (U.S.A.), and Dr T. M. De Stefano (U.S.A.). We have found nothing

to invalidate the statistics or cast doubt on their reliability. We are satisfied that the supporters of fluoridation have drawn the correct conclusions from the data and that the effectiveness of fluoride in reducing the prevalence of dental decay is established beyond all doubt. Those witnesses who have opposed fluoridation have not made any really serious challenge in regard to this aspect of the inquiry and, indeed, many of them admitted that their real objection to fluoridation was on some other grounds altogether. We are also satisfied that the action of artificially fluoridated water is indistinguishable from that of water containing naturally derived fluoride in the same concentration, or as Colonel Fuller put it, "biologically there is no difference between natural and artificial fluoridation".

CHAPTER 14: THE PROBABILITY OF FLUORIDE REDUCING THE PREVALENCE OF DENTAL DECAY IN NEW ZEALAND

101. The fluoride content of public water supplies in New Zealand is low, ranging from 0.05 to 0.5 ppm (Table 16). In all localities the fluoride concentration is much below that required for preventing dental decay (evidence of Dr Davies). The fluoride content of tooth enamel obtained from persons born in New Zealand was estimated by Harrison (1949a) working in the Nutrition Research Department of the Medical Research Council under the direction of Dr Muriel Bell (who gave evidence to this effect) and compared with the fluorine content of tooth enamel from European-born persons resident in New Zealand and from natives of Pacific islands (Rarotonga, Fiji, Western Samoa). The fluorine content of the enamel of New Zealand born persons was much lower than that of the other subjects examined.

102. The statistics giving the prevalence of dental decay in New Zealand children are comparable with those for low-fluoride regions in North America (Tables 17 to 20 inclusive). The validity of the comparison is established by the evidence of Dr Davies and Mr Ludwig who examined children's teeth at Newburgh and Kingston and related their own diagnostic standards to those of American dentists. This meets the criticism of Mr Gamble who said that different dentists would have varying standards of assessment.

103. Dr Davies drew the following conclusions from the data:

- (a) The prevalence of dental decay among New Zealand children aged 7 to 14 years is essentially similar to that among children of the same age living in Grand Rapids before fluoridation, in Muskegon in 1944, and in Sarnia in 1955.
- (b) The results of clinical examinations alone and of combined clinical and radiographic examinations show that the prevalence of dental decay is slightly higher in children aged 10 to 12, 13 to 14, and 16 years in New Zealand than in Kingston where the water supply contains no fluoride.
- (c) There is no significant difference in the prevalence of dental decay between New Zealand children aged 9 to 11 and 12 to 14 years and children of the same age living in Sarnia where the water contains no fluoride.
- (d) The variations between different cities in the United States and Canada are no greater than those between New Zealand and these cities.

104. Mr Ludwig has stated that in New Zealand dental decay is the same disease as dental decay elsewhere and fluoride may be expected to protect teeth against decay by the same mechanism as that which has operated elsewhere. It is, therefore, reasonable in his opinion to expect that fluoridation should be as effective in New Zealand as in North America if there are no disturbing factors. He went on to say that the high susceptibility to dental decay in this country is possibly due to the frequent consumption of food containing large quantities of refined carbohydrates. If this factor is much more important in New Zealand than it is in the United States and Canada, fluoridation of public water supplies may not be as effective as in North America; but he thought the difference in susceptibility is not so great as to influence the relative effectiveness of fluoride in this country.

105. The Napier-Hastings study was intended to determine precisely the degree of reduction obtainable in a typical New Zealand population, and in this connection Dr F. S. Maclean, Director of the Division of Public Hygiene, Department of Health, stated:

If only a 25 per cent reduction in the incidence of dental decay was achieved, the financial saving in respect of school dental services in Hastings would exceed the cost of the fluoridation.

106. In his evidence at both Hastings and Wellington Mr W. A. G. Penlington, a retired headmaster of the Hastings High School and a leading opponent of fluoridation, referred to the report of Hewat & Eastcott (1955) who compared the relationship between fluoride and dental decay in two groups of New Zealand children aged 13 to 16 years. One group (230 subjects) was concentrated in and around Auckland and the water supply apparently contained 0.4 to 0.55 ppm of fluoride. The other group of 770 subjects represented children in many parts of the country where the water supplies contained between 0.2 and 0.4 ppm of fluoride. A small difference in the prevalence of dental decay favouring the first group at 13 years of age had disappeared at the age of 16. Mr Penlington believes that this limited amount of research tends to shake the case for expecting that fluoridation will be effective in New Zealand. This is not the view of the authors who, at p. 76 of the monograph, stated:

The data available at the present time on caries in relation to fluorine in New Zealand drinking water cannot support any further discussion.

Mr Penlington has attached a significance to this research which is not warranted by the data, as the authors recognise.

107. Dr Bibby, Dr Davies, and other dental witnesses stressed the view that fluoridation is no more than a partial solution to the problem of dental decay; it is not a substitute for other means of prevention or for good conservative dentistry, both of which must also be applied if maximum benefits are to be obtained. The advocates of fluoridation believe that when a generation of New Zealanders has experienced the benefit of fluoridation and realised the value of natural teeth lasting into middle age and beyond, the people will display less willingness to sacrifice their teeth prematurely and become more responsive to dental health education. Such indirect results of fluoridation would be, of course, a matter of considerable importance in assessing its worth generally.

Conclusion as to Likely Value of Fluoridation in New Zealand

108. Having regard to the results of fluoridation of public water supplies in North America and their uniformity, to the susceptibility of children's teeth to dental decay in New Zealand, and to the known causes thereof, we feel satisfied that substantial benefits to dental health will follow from the addition of fluoride to public water supplies in New Zealand.

CHAPTER 15: DENTAL FLUOROSIS

109. It has been mentioned that the study of "mottled enamel" played an important part in events leading to the introduction of fluoridation (para. 62). It is necessary now to consider the nature and significance of this in relation to the fluoridation of public water supplies. Detailed evidence on the subject was given by Mr Ludwig, Dr Davies, Colonel Fuller, and Professor Shroff.

110. The enamel-forming organ of a developing tooth seems to be a very sensitive indicator of fluoride intake. The term "mottled" enamel is used loosely to describe any defect of the enamel characterised by pitting and discoloration. Such defects can be produced by fluoride, when the condition is known as dental fluorosis. The defects can be produced, however, by factors other than fluoride, and only the experienced dentist can distinguish the milder degrees of dental fluorosis from "mottled" enamel due to unknown causes (idiopathic mottled enamel). Both kinds of enamel defect are produced during the first 8 years of life and only at this period of life.

111. The researches of Dean (1954) in the United States and of Forrest (Table 21) in England show that severe dental fluorosis does not occur unless children are brought up in districts where the water supplies contain more than 1.9 ppm of fluoride. Severe fluorosis is unsightly and predisposes to the fracture of teeth. Mild dental fluorosis, characterised by opaque white spots or lines in the enamel, may be expected in 2 to 3 per cent of children when the water contains 0.9 to 1.3 ppm of fluoride. This condition has no adverse effect on the strength of the teeth. Very mild dental fluorosis, characterised by small opaque white areas or faint scattered lines involving not more than a quarter of the surface area of a tooth, may be expected in 6 to 10 per cent of children when the water supply contains 0.9 ppm of fluoride. The mottling is not detectable without close expert examination, and the front teeth are less affected than the back teeth. There is no disfigurement or aesthetically objectionable appearance.

112. The prevalence of dental fluorosis at Newburgh (1 ppm of fluoride) and Kingston (no fluoride), two cities in New York State, was studied independently by Russell (1956) and by Dr Davies (Table 22). Moderate and severe degrees of dental fluorosis were not found; and the enamel defects classified as mild dental fluorosis were less conspicuous than those due to unknown causes (idiopathic mottled enamel). Dr Davies concluded:

That dental fluorosis which occurs in fluoride areas (about 1 ppm) is of less significance than the idiopathic enamel defects which occur in both non-fluoride and fluoride areas.

113. The mottled enamel frequently seen in New Zealand is due to unknown causes but certainly not to excessive intake of fluoride. Some 5 to 6 per cent of 20,000 New Zealand children and young adults exhibited well marked idiopathic mottled enamel (Hewat, 1948); and Mr Ludwig found opaque enamel defects in 16 per cent of children at Napier and 11 per cent at Hastings.

114. With the exception of Mr Penlington, witnesses opposed to fluoridation have devoted little or no attention to mottled enamel. In his Wellington evidence Mr Penlington claimed that the work of Hewat and Eastcott (1955) made "some rather startling disclosures about the state of mottling in New Zealand adolescents" aged 12 to 17 years (9N1). He quoted a portion of the relevant paragraph at page 11 of the monograph and assumed this was a description of dental fluorosis but omitted the last sentence which reads:

It appears to correspond roughly to Dean's "questionable" or "very mild mottling", noted in connection with endemic fluorosis.

Hewat and Eastcott themselves make no claim in this work that the mottling is dental fluorosis. In the light of evidence given by Colonel Fuller, Dr Davies, and Mr Ludwig, we consider that the mottling described by Hewat and Eastcott is due to idiopathic enamel defects and is similar to the mottling found in Napier during Mr Ludwig's initial study.

115. On the basis of two percentages selected from the four which appear in Table VIIIc at page 62 of Hewat and Eastcott's monograph, Mr Penlington suggested there was a correlation between the mottling and the fluoride content of the drinking water. After considering the table as a whole, the manner in which the children were grouped and the nature of the mottling, we cannot accept the correlation: in fact the authors make no claim for such a correlation. Mr Penlington went on to suggest that many New Zealand adolescents exhibited endemic mottling because they were already ingesting as much dietary fluoride as they could safely take, much of it in the form of tea (six or eight cups daily). In this Mr Penlington is clearly mistaken. He overlooks the fact that mottled enamel, whatever the cause, is produced only during the formative period of the enamel, that is, during the first 8 years of life.

116. Dr H. V. Smith of the Department of Agricultural Chemistry and Soils, University of Arizona, U.S.A., with his wife, Dr M. C. Smith, carried out research into the effects of fluoride for many years. Following a communication from Mr Woodhouse, counsel assisting this Commission, he replied on 13 March 1957, and stated *inter alia*:

We opposed the fluoridation of drinking waters for several years on the basis of a lack of knowledge of the threshold level, or that concentration of fluorine, at which mottled enamel would be produced on the teeth of children who used the water during the time their permanent teeth were developing.

After remarking that they had been able to establish this threshold level in several climatic zones in the United States, he stated that they had "not noted any objectionable fluorosis of teeth produced by water whose fluoride content is below the threshold level". He then stated:

We also feared for a time that there were so many variables that it would be impractical to fluoridate water to a concentration which would effectively reduce the incidence of caries and still not produce fluorosis in a certain percentage of the users. Apparently this has been done at Newburgh, N.Y., for we saw no fluorosed teeth in children who had used water for 9 years which had been fluoridated to 1.0 to 1.2 ppm.

117. We are satisfied that fluoridation of water supplies at the optimum levels of concentration will reduce dental caries but will not cause harmful or unsightly fluorosis in teeth. A small percentage of children may develop delicate opaque white marking on their teeth (principally the back teeth) but only during the first 3 years of life. This feature is detectable only by close and expert examination and has no adverse effects on the teeth or any aesthetic disadvantages. Harmful or disfiguring fluorosis can develop only during the same early years of childhood and only when the fluoride ingested by the child is substantially above the optimum level and is ingested at that higher level for a lengthy period of time.

CHAPTER 16: PERIODONTAL DISEASES (DISEASES OF THE GUMS)

118. Mr M. V. Ross, a witness opposed to fluoridation, suggested that fluoride caused diseases of the gums and Mr Jordan made the same suggestion in his submissions. Mr Jordan quoted Dr M. Ginns, who had appeared before a Committee of the House of Representatives, United States Eighty-third Congress, to oppose fluoridation of water supplies. Dr Ginns made the following statement:

I mentioned the University of Toronto. Professor Box has indicated that where fluoridation is present naturally, the prevalence of gum disease is very high. (Weir Bill Report, page 196.)

119. Dr Davies denied that Professor Box, an international authority on periodontal disease, had ever expressed such an opinion and referred us to a lengthy statement in a report to the Minister of Health, Province of Ontario, Canada (1955). This report indicates that Dr Box himself had denied that he had ever made a survey of periodontal or pulp conditions in any area of naturally fluoridated water. It goes on to describe that at Colorado Springs, U.S.A. (2.6 ppm fluoride in domestic water for 75 years), no relation between the use of the domestic water and the incidence of periodontal disease had ever been discovered. In this connection, a letter is quoted written by Dr F. S. McKay, a periodontist living in Colorado Springs. His letter dated February 7, 1954, states in part:

I cannot characterise his (McCormick's) assertions as to conditions he ascribes to the use of fluorised water in any way other than as utterly and completely unsupported in my own experience and observation. No such relation between the use of our domestic water (2.6-2.8 ppm fluoride) exists in the tissues as set forth in his article among the inhabitants of this city. But not contented with my own observations I have delayed my reply to you until I could submit McCormick's statement to Dr Wilton W. Cogswell Sr. of this city. He is a practising exodontist and oral surgeon here for the past 34 years, an excellent pathologist and author of a textbook on Exodontia. He dismisses McCormick's statements as entirely unfounded and that in his own library of 35,000 cases of dental radiographs he has found nothing resembling what McCormick describes. His opinion is even more

emphatic than I have indicated. I know of no one here more capable of passing judgment in this matter than Cogswell. He states further that the morphology of tooth roots is in no way different than that among non-fluoride individuals contrary to McCormick's statement.

120. Dr Cunningham, Head of the Department of Periodontology at the Otago University Dental School, produced an article published by Dr Box in 1955 in which he stated:

I have never made a survey of gingival and periodontal diseases in any area where the water was naturally fluoridated . . . and I have written or published nothing on this subject. (*Dental Digest*. 61:172 - April 1955.)

121. We are satisfied that the statement attributed to Dr Box by Dr Ginns was not made by Dr Box. It is clear that in referring the matter to Dr Davies, Mr Jordan was unaware of the fact that Dr Box had issued his own denial that he had expressed the opinion. The confusion appears to us to have originated overseas and is one example of many instances which have come to our notice of statements, or opinions, being attributed quite erroneously to some authority on the subject.

122. Another reference to periodontal disease in relation to fluoride was made by Dr V. O. Hurme, who stated before the Delaney Committee that:

published and unpublished observations by many men suggest rather strongly that periodontoclasia, that is "pyorrhea", may be induced, or aggravated, by certain chemicals, including fluorides.

This statement was quoted to us by Mr F. Needham who is opposed to fluoridation. Since the hearings concluded, the same objection to fluoridation has been brought to our notice in other ways.

123. Mr Penlington has submitted a memorandum which quotes a report of the New Orleans Commission of Physicians and Surgeons on the subject of fluoridation. This report is signed by the various members of the committee, including a well known American surgeon, Dr A. Ochsner, who added his own comment as follows:

At the present time it is impossible to determine whether fluoridation is harmful or not. As a matter of fact, I think there is very definite evidence that fluoridation is probably harmful in that it produces periodontoclasia, which is just as bad or worse than dental caries which fluoridation is known to prevent . . ."

124. A memorandum submitted by Mr D. R. Masfield, New Plymouth, states, *inter alia*:

Mr W. Ramseyer, Cornell University, and Dr C. A. H. Smith, of New York City, observed periodontoclasia (gum disease) in albino rats receiving from birth 1.5 and 1.10 ppm fluorine in the drinking water. Alveolar (jaw) bone destruction was observed in rats that were sacrificed at 520 days of age. Animals sacrificed at 150 days of age did not exhibit this.

125. The foregoing extract appears to be a reference to a paper which had already been under our notice (Ramseyer, Smith, & McCay, 1957). This paper describes the effects of adding sodium fluoride to the drinking water of groups of rats. The mothers received water containing 1, 5, or 10 ppm of fluoride from the time of conception and the offspring continued on the same regime. No periodontal disease was observed in any of one group of offspring after 150 days. In another experiment lasting 520 days (according to the authors the life span of the albino rats used is less than 2 years) all the offspring were said

to have periodontoclasia and a small proportion of them had lost molar teeth. The authors observed distinctly greater loss of teeth in the animals receiving 5 or 10 ppm of fluoride in the drinking water. They say:

There was evidence of periodontal disease in all old animals that had been given sodium fluoride in the drinking water, as shown by alveolar bone destruction and increased porosity of bone.

This is contrasted with the statement "that only two cases of periodontal disease were observed among the animals killed at 520 days of age which had not received sodium fluoride supplementation in the drinking water".

126. There are certain unsatisfactory scientific features exhibited in this work. As the authors themselves properly point out the actual amount of fluoride received by the rats on fluoridated water is not certain because for an unknown, but apparently considerable time they were receiving a diet containing 14 ppm of fluorine on a dry basis. They state that this arose from contamination of the ingredients, but give no further explanation. The food and water consumption and survival data are not given, and there is an unexplained discrepancy in the caries experience of the rats in two of the experiments. The data on missing teeth do not uphold the statement that a "considerable number of teeth were missing among those given the additional fluoride". It appears also that the authors consider "there are differences in the effects of fluorides found in various compounds" and point to the fact that:

rats and dogs are usually fed for the whole of their lives upon diets rich in bone meal or bone. Nevertheless, in old age one does not see mottled teeth in such animals. Mottled teeth, however, have been produced in both species by feeding of sodium fluoride.

We are unable to accept the reasoning contained in this statement which makes no quantitative distinction between the readily available fluoride ions of soluble fluoride and the much less readily available fluoride of the relatively insoluble bone salt complex. The conclusion we express in paragraph 162, that all fluoride ions are the same irrespective of their source, is not affected by the view expressed in this work. We consider, moreover, that the authors' results cannot be accepted as a demonstration that consumption of water fluoridated to the level of 1 to 10 ppm produces periodontal disease in rats.

127. One of the three authors is C. M. McCay, PH.D., Professor of Nutrition in the Department of Animal Husbandry, New York State College of Agriculture at Cornell University. He appears to have been an opponent of fluoridation for some years. An example of his interest in the matter is a letter dated 28 April 1954, which is quoted at page 225 of the Weir Bill Committee's Report and in which he writes, *inter alia*:

I understand that when the representatives from England came to visit this country, they were piloted around in much the Russian fashion showing them only the people in favor of fluoridating water.

The report (1953) of the members of the British Mission provided no support for this rather colourful description of their researches but describes in some detail the wide itinerary which they followed either as a group or individually.

In a subsequent letter, dated 3 October 1954, Professor McCay wrote to Dr Eva Hill that:

As far as I know no physician in any health department in America has worked with fluoride.

Most of the work upon fluoride has been done in agriculture colleges because they were interested in getting the poison out of rock phosphate. Also many agricultural people have been engaged in helping farmers when they bring suit against the big aluminium companies for getting fluoride on their crops and land. Hence, agriculture has a distinctive point of view. As far as we know, no foreign country has yet permitted the fluoridation of water. I myself believe that fluoride should go into sugar so that it can be sold to those who wish it. We will send some mimeographed material under separate cover.

We find it surprising that Professor McCay was unaware by this date of the 10-year fluoridation study which had been permitted in Canada, or, on the other hand, of the part taken in fluoride investigations by physicians in the United States Public Health Services. A question on this latter point was put to Dr Davies at Auckland who thereupon named Dr N. Leone, Dr E. Geever, Dr N. Moran, and Dr E. R. Schlesinger as some of the physicians in the American Public Health Services who were concerned with fluoride investigations. We note, indeed, that on 27 May 1954, Dr Leone gave evidence in person before the Weir Committee, and this evidence is recorded in the report at page 371 – 146 pages further on than Professor McCay's letter of 28 April 1954 to which we have referred. These two letters have caused us to consider whether Professor McCay is entirely dispassionate in regard to the fluoridation of water supplies.

128. A copy of a statement of the Research Council of the Canadian Dental Association was made available to us by Dr Cunningham. This reads as follows:

Studies directed to an examination of the relationship of ingestion of fluorides in water to periodontal and gingival conditions permit the following conclusions:

1. Persons in an age group of 40–44 years residing since birth in areas where the fluoride content of water was negligible, have lost four times as many teeth as persons of the same age group living in areas where the fluoride content in the water supplies is 2.5 ppm. (Russell & Elvove, 1951.)
2. There is no significant difference in the prevalence of gingivitis between persons (mean age 57.1) residing in an area which contains 8.0 ppm of fluorides and those (mean age 55.3) living in an area with a fluoride-free water supply (Zimmermann, 1955). The presence of 1 ppm fluoride in drinking water had no effect on the gingivitis of children (age 6 to 14). (Brown *et al.*, 1955.)
3. There is no significant difference in the amount of calculus formation and alveolar bone resorption among residents (mean age 57.1) living in an area containing 8 ppm of fluoride and the residents (mean age 55.3) of an area with fluoride-free water (Zimmermann, 1955). The average length of residence of the two groups in these areas was 37 and 38 years respectively.
4. A radiographic study of rats on a fluorine-free diet (McClendon and Gershon-Cohan, 1954) revealed extensive periodontal disease in the molar regions and freedom from these defects in rats receiving 10 ppm fluorine in drinking water. The evidence suggests that fluorine may be an essential trace element for optimal nutrition in rats.

There is no evidence that periodontal disease is more prevalent in areas where the water supply contains fluoride than in fluoride-free areas. Continuing studies can be expected to add further details to the knowledge already available.

Then follows the bibliography which is incorporated by us in the bibliography contained in Appendix A.

129. Dr Cunningham, in expressing his own opinion, said:

I have not found any scientific evidence of any relationship between the prevalence of periodontal disease in a community and the fluoride content of its water supply. From my understanding of the causes of periodontal diseases, I would have been very surprised to find any such relationship.

Dr Watt, another specialist in periodontology, agreed with Dr Cunningham. We are satisfied there is no valid evidence to suggest that fluoridation can cause disease of the gums.

CHAPTER 17: DISEASE OF THE TOOTH PULP

130. On several occasions during the inquiry the views of an English dentist, Mr Charles Dillon, have been mentioned, for example, in Mr Dowling's submissions, in Mr Jordan's cross-examination of Dr Davies, and in exhibits, such as Dr Exner's (1955) Report on Fluoridation, submitted by the opponents of fluoridation. Mr Dillon, who is critical of fluoridation, has claimed that the consumption of fluoridated water causes damage to the pulp of teeth. This matter is the subject of a memorandum by Professor Shroff, a dental pathologist who is Head of the Department of Basic Dental Sciences at the Otago Dental School. Giving evidence in Dunedin, Professor Shroff criticised Mr Dillon's interpretation of the published radiographs and said there is no proof in the evidence offered by Mr Dillon that the calcifications in the pulp were caused by fluoride. Identical calcifications in the pulp are very common, they occur in most New Zealand teeth and yet New Zealand water supplies are notoriously deficient in fluoride. The calcifications apparently have no effects on the health or vitality of the tissue. Professor Shroff quoted several authorities in support of his statement. We accept Professor Shroff's view that consumption of fluoridated water will not cause specific damage to the pulp of teeth.

CHAPTER 18: SUMMARY OF OUR CONCLUSIONS ON THE RELATION OF FLUORIDE TO DENTAL HEALTH

131. We regard the following matters as established:

- (1) Fluoride is a natural component of all teeth and by hardening their mineral structure it makes them more resistant to dissolution by acids.
- (2) Excepting radioactive fluoride, all fluoride ions are the same irrespective of their origin, and they behave in the same way in both a chemical and a biochemical sense.
- (3) In New Zealand the fluoride content of potable waters is considerably below 1 ppm.
- (4) In areas where there is fluoride in drinking waters at optimum concentrations, whether naturally present or artificially added, the prevalence of dental decay in children is at least 50 per cent lower than in areas where the fluoride content is 0.2 ppm or less. In the higher fluoride areas about one-third of all children escape dental decay entirely and the beneficial effects continue into adult life.

- (5) There is no evidence that the consumption of fluoridated water would do harm to the pulp of the teeth or to the tissues which surround and support them.
- (6) The regular ingestion of a substantial excess of fluoride (more than 1.9 ppm.) in the drinking water may cause dental fluorosis. This is only one type of mottled enamel. Other enamel defects unrelated to fluoride are common. Enamel defects can develop only during the years of childhood.
- (7) When the drinking water contains 1 ppm fluoride, or slightly more, the incidence of dental fluorosis has no significance.
- (8) As the result of painstaking and thorough scientific observations conducted over a period of at least 40 years, there is a rational basis for the proposal to add fluoride to public water supplies in which this trace element may be deficient.
- (9) The present state of dental health in this country is a matter for serious public concern.

132. For all the foregoing reasons we find that the fluoridation of public water supplies in New Zealand would be followed by substantial benefits to dental health. We think it is a process which should be used widely for that purpose.

We now turn to consider whether there can be any possible objections to fluoridation on other grounds.

*Part IV***THE BEHAVIOUR OF FLUORIDE IN THE BODY****CHAPTER 19: SCOPE OF INQUIRY IN RELATION TO
GENERAL HEALTH**

133. The second of the questions upon which we were directed to make inquiry is "whether any disadvantages may result from the addition of fluoride to waters naturally containing less than one part of fluoride per million". The most important aspect of this general question is the effect of fluorine on the general health of the people. We propose to deal with this before considering any possible disadvantages of the fluoridation of water supplies which might arise in other directions.

134. The question as to whether fluoride is harmful to bodily health obviously raises a matter of the greatest importance. The subject itself covers an immense field in medicine and chemistry and their ancillary sciences and we have heard a great deal of evidence on various aspects of it. In addition to evidence given orally we have been referred to a large number of books, periodicals, and other printed material, all of which we have examined. Wherever possible we have taken advantage of any reference to authority in these publications and have gone to the original source.

135. Although most opponents of fluoridation accept the view that fluoride exists naturally in most water supplies and is to be found in practically all foods, they distinguish between so-called "natural" fluoride and "artificial" fluoride which would be added physically if a water supply was to be fluoridated. The "natural" fluoride they regard as safe and, indeed, even essential to the body: the "artificial" fluoride they regard as a different and a dangerous substance. Arising out of this, arguments have been put before us that artificial fluoride causes or might cause a wide variety of named illnesses.

136. Other witnesses, most of whom possess medical or scientific qualifications, have said that the characteristics of the fluoride naturally in water and foods on the one hand, and of the fluoride proposed to be added to water supplies on the other, are the same in all respects. They deny that at the levels of concentration relevant to the process of fluoridation there can be any danger to health, and they provided many detailed explanations of the principles upon which they based their conclusions.

137. The answer to the general question requires in the first place an examination of the following matters, all of which are dealt with in this part of the report:

- (1) The nature and characteristics of fluorine in its various forms.
- (2) The extent to which the body eliminates or retains fluoride following ingestion.

- (3) The level at which the substance becomes toxic first in an acute sense following a massive dose and, secondly, in a chronic sense due to the regular ingestion of smaller doses.
- (4) Levels of toxicity in relation to the quantities of fluoride likely to be ingested by individuals if water supplies were fluoridated.

In Part V we consider the individual complaints put before us that the substance is harmful to health. In Part VI we have analysed the opinions of and qualifications of the professional witnesses who consider there are hazards to health in the fluoridation proposals. In addition we have dealt specifically with the anxieties of certain residents of the Hastings area. We turn to an examination of these matters in the order listed in this paragraph.

CHAPTER 20: THE NATURE AND CHARACTERISTICS OF FLUORINE

138. Under this heading we propose to consider whether or not a distinction may properly be drawn between fluoride naturally in water and the fluoride proposed to be added to it. The question has been debated before us in different ways and we regard it as necessary to include, in our survey of the evidence available on this topic, our view as to the nature and occurrence of the substance in both its organic and inorganic forms.

139. Most elements have several distinct manifestations. These may be listed in the following way:

- (1) Their atoms, or molecules comprised of those atoms, may exist in a free state as elements.
- (2) Their atoms may become ionised by the loss or gain of an electron or electrons and thereafter exist as ions of the element.
- (3) Atoms or ions of the element may join with other elements to form compounds.
- (4) An atom or atoms of the element may become bonded with carbon and exist as an organic compound of the element.
- (5) The ion or atom of the element may have a radioactive form. This fact has no relevance to the present Inquiry and we will not consider it further.

140. Concerning the foregoing paragraphs, we regard it as established that, excluding isotopy which has no relevance, the atoms of an element are all alike and possess characteristics unique unto themselves. In the same way ions of that element, derived from atoms which have lost or gained an equal number of electrons, are also all alike and possess unique characteristics. The addition or removal of one or more electrons to or from the atom brings about this phenomenon and this is the reason for the fact that atoms and ions of the one element have differing characteristics and behave differently the one from the other.

141. Just as there are differences of behaviour and characteristics between atoms and ions of the one element so are there differences between compounds of that element and its atoms or its ions. Moreover, the organic and inorganic compounds of it have properties which the other does not possess. A failure to understand or keep in mind these various distinctions could be the cause of considerable confusion.

142. We have been told, and accept it as established, that fluorine does not occur in the free state in nature. When prepared in the laboratory the free element is an extremely noxious gas which reacts violently with many other substances. Since there may be some confusion in the public mind on the point, it should be made clear that the use of fluorine in its elementary state in the process of water fluoridation has never been contemplated. As Mr James pointed out, any discussion of the properties of elementary fluorine is quite irrelevant.

143. All witnesses agree that in nature fluorine is found only in combination with other elements. In the solid minerals the fluorine is present as negatively charged fluoride ions in the crystal lattice paired off with positively charged ions of some other element. For example in fluor spar or fluorite (calcium fluoride), fluoride ions are combined with calcium ions. The fluoride ion differs from the atom of fluorine in that it possesses one additional electron.

144. When the fluorine compounds are leached out of the rocks by natural processes to give a very dilute solution in water, the positive and negative ions are separated by molecules of water and ions derived from water. The calcium and the fluoride ions exist in solution as separate entities with properties completely independent of those of the compound (or salt) from which they were derived. The same is true of sodium and fluoride ions when solid sodium fluoride is dissolved in water.

145. If radioactive fluoride is excepted, all ions of fluorine, irrespective of their compound of origin, are the same and do exactly the same things in a chemical and in a biochemical sense as is stated in paragraph 140. This is the view of Dr Fyfe to whose evidence we referred in paragraph 59, and it is the view held by all the supporters of fluoridation who expressed opinions on the nature of fluorine (Colonel Fuller, Mr James, Dr Burns, and Dr Davies). Indeed, Dr Davies said that the identity of all fluoride ions follows from the fundamental principles of chemistry.

146. In the language of chemistry substances like calcium fluoride and sodium fluoride are called *inorganic substances*. This has nothing to do with their location in nature: an inorganic substance may be found in minerals or in the body of a living creature.

147. Fluorine is known to combine with the element carbon. In the language of chemistry any compound of fluorine with carbon is called an *organic substance*. Again this has nothing to do with the location of the substance in nature: an organic substance may be found on the shelf of a laboratory, in nature outside a living creature or in the body of a living creature. The known organic compounds of fluorine are extremely stable and do not dissociate to give fluoride ions in aqueous solutions.

148. We think it necessary to make this excursion into the realm of chemistry because some witnesses opposed to fluoridation apparently hold different views. Most of the opponents of fluoridation accept the fact that fluorine exists in water supplies by virtue of the solution of minerals as water passes through or over rocks and soil. They accept the fact that fluorine is present in most foods. The fluorine present in natural water and in food (plant or animal) is regarded as harmless by most, if not all, of the witnesses opposed to fluoridation. Madam Mira Louise James and Dr Mudie have said that natural fluorine is

essential to life. Nevertheless, some of these witnesses look upon the chemical (e.g., sodium fluoride) which is to be added to water in the fluoridation process as a substance that is artificially produced and behaves differently from natural fluorine compounds. They consider that chemically prepared fluoride is poisonous and base objections to fluoridation on this belief.

149. This is a confusing issue which must be cleared up before we can give our decision on the toxicity of fluorine. The evidence of Madam Mira Louise James, Dr Mudie, and Mr Cooper contain statements which are the key to the alleged distinction between "natural" and "artificial" fluorine.

150. Madam Mira Louise James, whose professional name, Mira Louise, was frequently mentioned with approval by various witnesses opposed to fluoridation, is the compiler of a pamphlet called *Fluoridation the Poisoner*, which was produced as an exhibit by several witnesses. She describes herself as a naturopath and nutritionist. The hearings in Dunedin coincided with a visit this lady was making to New Zealand from Australia, and since she happened to be in Dunedin at the time, Mr Woodhouse invited her to appear before the Commission. She was good enough to do this and to express her views first in Dunedin and later in Wellington. She was highly critical of the fluoridation proposals, but the following extracts appear in the notes of evidence as answers to Mr Woodhouse (7M 1 *et seq.*):

Do I correctly interpret your view like this? You agree that there is nothing wrong with fluoride in water supplies provided it is there naturally? . . . Ah, definitely, that is the big point.

That is what you agree? . . . Definitely.

And if the fluoride is there naturally there is a desirable level for that natural concentration? . . . Definitely.

And you regard fluorides as a natural constituent of a normal diet? . . . Fluorine that is taken up through the plant.

And of course you support that view by referring to the fact that practically all foods contain this substance? . . . Yes.

And you would be fair enough to say that it is an essential thing for human beings to have it? . . . Well, if you don't have fluorine you are just unbalanced. . . . It is a very necessary element. . .

You have nothing against fluorine as such? What you object to is the artificial addition of it? . . . Definitely.

Is that a fair way of putting it? . . . I would say I do teach in every lecture I give that fluorine – this is the natural fluorine which comes to us through the roots of the plant and so on – is an essential to human life and I do warn people against the chemical preparation because I do not think it is possible to interfere with nature.

Is that opinion of yours based on this fact – that because this substance is so widely distributed through nature, it would be surprising if nature did not intend it to take a part in our bodily make up? . . . Definitely. Nature gives us sixteen main elements and a few trace elements.

You regard this as a trace element? . . . No, it is one of the inorganic elements of the body used every moment of the day. In fact, if I didn't have enough fluorine I wouldn't be sitting here arguing – I wouldn't have the courage or the backbone.

Anyway, you are a great help. In regard to the critical views which you are repeating from this booklet – those are directed not at fluorine, but at the artificial addition of it? . . . Definitely.

So that the only real argument between the people in favour of this, on the one hand, and yourself, gets down to this, doesn't it – that you consider that the fluorine there naturally is something different from the fluorine put in?

And again she said, "Definitely".

151. In her prepared statement at Wellington Madam Mira Louise drew a distinction between an inorganic and an organic chemical and said (9X 1):

And as I see it, the decision of this Commission revolves around *just this point*. . . . An inorganic chemical is the crude mineral element of earth, rock, etc., which cannot be utilised in any way by the human or animal body until it has been transformed by the plant. *Inorganic sodium, that is salt in its crude form*, causes cancer, high blood pressure, kidney complaints, and so on. Inorganic fluorine, *in its crude form*, causes mottled teeth, bone disorders, etc. But when these two crude elements are taken up by the plant, they become organic chemicals, and are fully utilised by the human system.

Subsequently Madam Mira Louise answered Mr Woodhouse as follows:

And how does the fluoride get into the water naturally? . . . By the earth formation, rock, and various ways.

You mean the water trickling through the natural minerals? . . . That is right.

And if that has happened, you agree that the water is suitable for drinking.

. . . Yes, providing it does not go above—

A particular level of concentration? . . . Yes. Then you would have to balance the diet with foods that had a low natural fluoride content.

But you say that because you accept the view that over about 1½ or 2 ppm mottling develops. I thought that is what you told us in Dunedin? . . . That is right.

That is the sort of thing you have in mind? . . . Yes.

So that as you told us down there, you think that fluorine is essential to the body — I think you said you would not be there if you had not got some. Is that right? . . . Yes.

You think that it is a good thing that it is in our water supplies provided it is not over a particular level of concentration? . . . If it is there naturally — yes.

If it is there naturally. And you agree that it gets there naturally by the water trickling over the natural minerals? . . . Yes.

Do you accept the evidence of the scientific people that such natural minerals include fluorspar? . . . Yes, because that is the original source.

Yes. And water trickling over that substance in the ground picks up some of the fluoride from the substance, thereby leaving it as one finds it in the water naturally? . . . Yes.

Would you have any objection to offer to the same substance being ground and refined in the way that was described this morning for the purpose of adding part of that to the water? . . . Yes, definitely.

Can you tell us why — just in a sentence? . . . Because no one can — I do get rather garrulous on the subject.

I don't want to cut you short, but I think it rather important that you should be in a position to explain your view. . . . Yes; I could mention, if you want to improve the water supply, let us put the rocks containing those elements and bring it in naturally—

You mean — this is not a facetious suggestion — but if one had a large enough reservoir, you would not object to lorries trucking the natural fluorspar and putting it into the reservoir so that we could take the fluoride out of the bulk supply? . . . Quite. That would be the perfect way of doing it, the nearest way we could get to the natural way.

But in effect, as you told us in Dunedin, you accept the idea that fluorine is essential to the body, that it does good to teeth, provided it is not over a particular concentration and provided it gets into water naturally? . . . Yes, that is right.

152. In this evidence Madam Mira Louise agreed that fluoride is a body constituent (“it is one of the inorganic elements of the body”); she agreed that fluorine is a natural constituent of a normal diet provided it is fluorine that is taken up through the plant; and she agreed that there is no objection to a certain concentration of fluoride in water supplies provided it is the fluoride naturally present. The last point is confirmed in her Wellington evidence. She had no objection to the

addition of fluoride to a reservoir if the additive were crude, natural fluorspar. Indeed, she said that would be "the nearest way we could get to the natural way".

153. Despite her opinions as summarised in the foregoing paragraph, at page 9X 1 of the Wellington evidence, Madam Mira Louise drew a sharp distinction between an inorganic and an organic chemical. The term "inorganic chemical" appears to be used in what we regard as the proper chemical sense while she was referring to minerals. Nevertheless, she said, ". . . an inorganic chemical cannot be utilised in any way by the human or animal body until it has been transformed by the plant"; and speaking of sodium and fluorine, she said, "But when these two crude elements are taken up by the plant they become organic chemicals and are fully utilised by the human system." If the term "organic" is used with its proper chemical meaning, this statement implies that fluorine combines directly with carbon in the plant and only this organic compound is utilised by the human system. On the other hand, the term "organic" may have been used by her in a different sense to mean fluorine present as fluoride in a living organism; for earlier she had said fluoride "is one of the inorganic elements of the body".

154. If Madam Mira Louise regards fluoride that is located in a living organism as a substance different on that account alone from fluoride that is outside a living organism, she believes in a concept which, in our understanding, is not accepted by chemical or biochemical science. A somewhat similar point of view was expressed by Mr F. C. Cooper on behalf of the New Zealand Organic Compost Society, Incorporated, who said that:

all the elements in our foodstuffs that come through nature are provided with that life element . . . there is a vast difference between the chemical substance and the one nature produces.

By using the term "life element" Mr Cooper seems to be touching on "vital force" and the theory of vitalism which is not consistent with the scientifically established principles of physiology, biochemistry, and pharmacology. For similar reasons we are unable to accept several arguments used by Mr Grove which were based on the theory of homoeopathic medicine, and refer to a concept of drug energy or "a dynamic effect on the vital force of man".

155. If, however, Madam Mira Louise believes that fluorine in the food is bound to carbon in an organic compound, she did not explain how such firmly bound fluorine is released from the carbon constituent and becomes available to the animal body as fluoride. On the other hand she did not explain why natural inorganic fluoride in the water supply could be directly utilised by the animal if it must first pass through the plant.

156. Dr Elizabeth C. Mudie, a registered medical practitioner, also gave evidence in Dunedin against fluoridation. The following passage is taken from the note of her evidence (7R 2):

I understand that earlier you mentioned that this substance was a trace element? . . . In the food?

Yes, in the food. Do you think that it is essential as a trace element in the body? . . . Oh, I've got all the trace elements in my body that I want!

But as a nutritionist, you regard this as a necessary trace element, do you? . . . I have just said so, haven't I?

That is what I am wanting to make sure. . . . You cannot put trace elements into the body just by measuring them out wholesale to people.

I wasn't asking that. I just wanted to make sure that you did regard it as a necessary trace element. . . I have just said it is this. Fluorine, as such, has an effect on the enamel of the teeth.

What you are concerned with is the method of getting this trace element into the body? . . . No. My chief concern is the keeping of the Magna Carta and the Bill of Rights. That is my chief concern.

You are not concerning yourself with the fact that it gets there? You are concerned with the way of getting there? . . . Exactly, but if we eat food containing it we will get just what nature intended; but it is a different thing having fluorine that is manufactured and organic fluorine as we get it from the plants. The plants add something to the fluorine, presumably.

Tell me if this is correct – you are not concerned that natural fluorine gets into the body? . . . Not at all.

You are concerned with the way it gets there? . . . quite. As long as it gets there by nature's methods I don't mind in the least – I am with you.

Dr Mudie agreed that fluorine is present in food and is utilised by the body:

if we eat food containing it we will get just what nature intended; but it is a different thing having fluorine that is manufactured and organic fluorine as we get it from the plants. The plants add something to the fluorine, *presumably*.

Again it is not clear whether Dr Mudie was using the term "organic fluorine" in a vitalistic sense or whether she implied that fluorine was present in plants as a carbon compound or some other compound.

157. Another witness opposed to fluoridation was Mr Maling, who had graduated B.Sc. in chemistry and claimed some experience in biochemistry by virtue of service in the biochemical laboratory of a military hospital. Mr Maling is in retirement owing to illness following the last war. In cross-examination Mr Maling agreed that all fluorine ions are the same, but in his evidence in chief he had opposed the use of inorganic fluorine and expressed the view that fluorine bound in carbon compounds would be less toxic. In support of this contention Mr Maling said:

I would like to give scientific support to those who oppose the use of *inorganic* sources of fluorine. The fluorine salts of the strong alkalies, including sodium, are highly ionised and, therefore, soluble in a chemically highly potent form. On the other hand, the fluorine salts of calcium and magnesium, although still inorganic, are less ionised.

And in cross-examination he said:

The point of view I take is that there is a difference in degree of ionisation, and that is the important point.

In calcium fluoride you have fluoride ion in a much less ionised state than you have in sodium fluoride, and, therefore, it is less toxic.

In advancing these views we are satisfied that Mr Maling has overlooked some important facts regarding the fluorides. First, crystallographers consider that calcium, magnesium, and sodium fluorides are almost wholly ionic in the solid state; and, secondly, the discussion of fluoridation is relevant only to very dilute solutions in which ionisation of all those salts is virtually complete. Moreover, modern chemistry does not reveal in regard to the degree of ionisation of these substances any differences that can have any significance in this inquiry. There is a difference in toxicity of equal weights of sodium and calcium fluorides but only because the one is more soluble than the other. Sodium fluoride is about a thousand times as soluble as calcium fluoride. Since insoluble material is not absorbed into the body, a difference in toxicity may be expected if an equal weight of the two substances is given – the sodium fluoride in solution and the calcium fluoride mainly suspended in a

solid state on account of its poor solubility; but if solutions of sodium or calcium fluoride are made to have a concentration of say 1 ppm of fluoride ions as in the process of fluoridation, the biochemical actions in respect of fluoride ions will be the same. These expectations are borne out by experimental work (see Largent, 1954).

Mr Maling's views on the toxicity of fluorine which led him to suggest that if fluorine must be taken it should have an organic form "to shield the toxic element", seem to us to be speculation based on an imperfect conception of the selective action of organic arsenicals. This process is described precisely by Professor Albert (1951) in his work "Selective Toxicity". Mr Maling also suggested that fluorine was a more potent poison than other elements when he said:

One witness yesterday referred to monofluoroacetic acid and explained that its toxic properties were due to the bond between fluorine and carbon. This is partly correct, but it does not account for the evidently much greater toxicity of this substance (used so successfully in lowering the rook population recently) compared with the well known weedkiller, T.C.A., trichloroacetic acids, which has *three* chlorine atoms bonded to carbon, and would obviously have been used in preference if its toxicity had been at all comparable. Therefore, the toxic properties of the monofluoroacetate are not just due to the type of bonding but to the fact that the element fluorine is a very potent poison.

Here, Mr Maling has drawn a false analogy by supposing that the toxic properties of a molecule are due solely to one of its constituent elements. We think that in expressing this view Mr Maling was omitting to take into account the mechanism of fluoroacetate poisoning. This depends on the unique biochemical properties of the monofluoroacetate ion as a whole and not merely on the properties of the fluorine component. To put it in simple terms, the body fails to distinguish between the monofluoroacetate ion and the normal acetate ion and uses the former as if it were the latter. The result is a serious blockage of the biochemical machinery. This mechanism is fully explained by Sir Rudolph Peters (see para. 165 *infra*) in his Croonian Lecture (1952). There are other facts which show that Mr Maling's hypothesis is untenable. For example, trifluoroacetate, which has *three* fluorine atoms bonded to one carbon atom, is not toxic (Zipkin & McClure, 1951) when administered to rats in drinking water at the level of 50 ppm; and the work of Saunders (1947) shows that the monofluoro-derivatives of the straight-chain fatty acids containing 3, 5, and 7 carbon atoms are relatively non-toxic in comparison with those having 2, 4, 6, and 8 carbon atoms.

158. We have indicated that we have not been persuaded by Madam Mira Louise, Dr Mudie, or Mr Maling that their arguments in regard to the nature of fluorine are valid. It remains, however, to describe our conclusions as to the fluoride ions found naturally in water and the additional ions to be found there following treatment by fluoridation. We shall refer also to the fluorine found in plant foods.

159. We have had no difficulty in deciding upon the characteristics of fluoride. This is set out with absolute clarity in the evidence of Dr Fyfe and in the cross-examination that followed. As we have already mentioned, all fluoride ions are the same and have the same chemical properties irrespective of their source. Even prominent opponents of fluoridation in the United States, such as Dr G. L. Waldbott and Dr F. B. Exner, have been quoted as accepting the identity of fluoride ions.

160. No one has questioned that small quantities of fluoride ions exist in natural waters and there has been no evidence to suggest that potable water contains organic compounds of fluorine. If such compounds derived from vegetable matter do gain access to potable water, the quantity must be quite insignificant. To this extent the nature of fluorine in water is simplified. Floridation involves the addition of a soluble fluoride (e.g., sodium fluoride or according to a recent suggestion, flourspar) to the water. We are satisfied that this process does not add a substance that is foreign to the water. It brings about a small difference in the concentrations of the ions already present.

161. Some witnesses pointed to the fact that the ratio of the ions in the water is disturbed and laid stress on the ratio of calcium ions to fluoride ions. In our view the answer to this is to be found in the fact that the difference in ratio so brought about is actually less than the differences which exist between one natural water and another. This point was mentioned by Professor R. S. Harris in his evidence before the Delaney Committee and by Dr Waldbott (1955a).

162. For the foregoing reasons, we find that there is no reason to make any distinction between the fluoride naturally present in water supplies and fluoride which is added in the fluoridation process. There is no change in the colour, taste, or odour of the water when fluoride is added to it. The natural fluoride ions and the fluoride ions added in the water treatment are chemically identical and, as the evidence has shown, natural water and fluoridated water have the same effect in the biological test at issue, namely, reduction in the prevalence of dental decay. We are quite satisfied that any argument which attempts to distinguish between "natural" and "artificial" fluoride cannot be supported on any rational basis.

163. We have had some difficulty in attempting to define the nature of fluorine in foods. Existing analyses of foodstuffs give the total fluorine content and do not distinguish between inorganic fluoride and organically combined fluorine (i.e., carbon compounds of fluorine). There appears to be very little knowledge of the organic compounds of fluorine occurring in nature. Mr James said:

As far as I know, organic fluorine compounds have not been found in food or water. At any rate it is known that the fluorine in foods is available for tooth formation.

164. There is no scientific evidence to show the existence of organic fluorine compounds in animal tissues.

165. The only organic fluorine compound which has been extracted from plants and characterised is the extremely poisonous substance fluoroacetic acid (Peters, 1954) obtained from the South African poisonous plant, *Dichapetalum cymosum*. There is no evidence that the firmly bound fluorine can be liberated from this substance by mammalian digestive processes although there is some evidence that the fluorine can be liberated slowly by internal bodily processes in the rat (Hagan, Ramsey, & Woodward, 1950). Despite this the elegant researches of Sir Rudolph Peters and his colleagues on the mechanism of fluoroacetate poisoning show that the extreme toxicity of fluoroacetate depends on the molecule remaining intact. The meagre scientific evidence available on the pharmacology of artificial organic fluorine compounds

which has been reviewed by Zipkin & McClure (1951) and by Chenoweth (1949) emphasises the stability of the bond between fluorine and carbon.

166. Nevertheless, as Mr James pointed out, there is clear evidence that at least part of the fluorine of foods is available to the body, and some recent experiments indicate that the retention of dietary fluorine is the same whether the fluorine be supplied as sodium fluoride or as natural fluorine in foods (Krylova & Gnoevaya, 1956).

167. After studying all the evidence placed before us, we can find nothing to lead us to definite conclusions about the nature of fluorine in foods. It is possible that some of the fluorine in plant foods is fluoride, as it is in tea leaf; it is equally possible that some of it is present in organic compounds. It is certain, however, that much of the total fluorine in all foods is available to the animal body as fluoride.

168. The utilisation of fluoride can be readily understood, but nothing appears to be known for certain about the availability of organic fluorine compounds if such exist in foods in significant quantities. We are quite satisfied, however, that since the amount of fluoride derived from food is small in comparison with the amount derived from water and tea, lack of certainty regarding the nature of fluorine in plant foods is not of significance in this inquiry.

169. Arising out of the general question as to the nature of fluorine is the related matter of the source of supply of the chemical proposed to be added to water supplies and its purity.

170. Many witnesses opposed to fluoridation have objected that the chemical which is proposed to be added to the water supply is produced artificially. Some have made the bare assertion, unsubstantiated by any real evidence, that it is a trade waste of the aluminium industry containing impurities such as arsenic. Dr Eva Hill criticised the use of what she called: "A trade waste chemically impure and unfit for human consumption". In the absence of any evidence to show the extent, if any, to which the waste of the aluminium industry is converted into fluoride used for treatment of water supplies overseas, we find it impossible to reach any conclusion on this matter: but so far as the fluoride compound used at Hastings is concerned, there is no doubt whatever. The evidence of Mr Fish, Hastings City Engineer, supported by documents, shows that the supplies of sodium fluoride were manufactured from rock phosphate by Imperial Chemical Industries and forwarded to the city by the same firm. Mr James informed us that:

The sodium fluoride that is added to water for health reasons is manufactured from natural fluorides, mainly apatites.

Mr Johannesson stated that a natural mineral, fluorspar, had recently been used for this purpose. This is one of the minerals which provide the fluoride to be found in natural waters. In view of our decision that the alleged distinction between natural and artificial fluoride is invalid, it appears to us that the source of fluoride is quite immaterial so long as the compound supplied conforms to required specifications of purity.

171. The question of arsenical impurities was raised by Mr Hannah and by Dr Eva Hill. In this connection, however, Mr Ludwig presented unchallenged evidence to show that the sodium fluoride used at Hastings contained as little as 0.014 per cent of arsenic expressed as arsenious

oxide. We are perfectly satisfied that the minute trace of arsenic which is present in the fluoridated water at Hastings is entirely harmless. Mr Ludwig put this graphically by suggesting that an individual would need to drink Hastings water daily for 1,750 years to obtain a toxic dose. When Dr Eva Hill was told of Mr Ludwig's evidence, which she accepted, she too was satisfied that the amount of arsenic added as an impurity in the fluoride was quite harmless.

Conclusions as to the Nature of Fluorine

172. We regard the following matters as established:

- (1) The element fluorine does not occur in a free state in nature and has no relevance to the fluoridation process.
- (2) The process is aimed at increasing the concentration of fluoride ions in water supplies and those ions do not possess the properties of fluorine in its free elementary state.
- (3) Excepting radioactive fluorine which is not relevant, all fluoride ions are alike and, irrespective of their source, do exactly the same things in both a chemical and a biochemical sense.
- (4) Organic compounds of fluorine are extremely stable and do not dissociate to give fluoride ions in aqueous solution.
- (5) No distinction can be drawn between the fluoride naturally in water and the fluoride proposed to be added to it by the fluoridation process.

CHAPTER 21: THE INTAKE, EXCRETION, AND STORAGE OF FLUORIDE IN THE BODY

173. In the preceding chapter we have stated our conclusion that no distinction can be drawn between ions of fluorine whatever their origin. We proceed now to a consideration of the processes by which the body deals with the fluoride ingested. In the following Chapter 22 we examine the extent to which the substance is toxic. It is not difficult to understand that these questions depend upon:

- (1) The amount of fluoride ingested during a given period of time;
- (2) The amount of fluoride which is eliminated by the body in an equivalent period of time;
- (3) The length of time any fluoride is retained in the body; and
- (4) The location chosen by the body to store any fluoride retained by it.

174. Amongst those who gave evidence in support of the fluoridation proposals, was Muriel E. Bell, M.D., Nutritionist to the Department of Health, chairman of the Nutrition Research Committee of the Medical Research Council of New Zealand, and director of the Committee's Laboratory. Her researches into the effect of fluorine on the body have been carried out at intervals over a period of 30 years, and particularly during the last 15 years. She appeared before us in Hastings and in Dunedin as the chief witness supporting fluoridation on questions of physiology, biochemistry, and toxicology and their applications in medicine. She gave evidence in regard to the physiological questions posed in the preceding paragraph, and her evidence was confirmed by Edward Roche, M.D., C. R. Burns, M.D., consultant physicians, and

by Professor Elizabeth Gregory, PH.D., Dean of the Faculty of Home Science, Otago University, and a member of the Nutrition Research Committee.

175. *The Intake of Fluoride*—In normal environments this depends upon the amounts of fluorine in foodstuffs and in drinking water, together with the quantities of those substances in the diet of the individuals concerned. The facts stated in the following paragraphs 176 to 182 deal with these matters.

176. Most solid foods in a mixed diet contain very small quantities of fluorine ranging from almost zero to 1.6 ppm. For example, beef, mutton, and vegetables contain less than 0.2 ppm; dry cereals and white bread about 1 ppm. Sea foods, however, are much richer in fluorine, e.g., fresh fish 1.6 to 7.0 ppm and canned fish 7.3 to 12.5 ppm (McClure, 1949; Harrison & Bell, 1947). The data are given in terms of elementary fluorine rather than in terms of fluoride ion to conform with the method of chemical analysis. Food that is cooked in fluoridated water will absorb some extra fluoride from the water.

177. Of the common beverages, tea is an important source of fluoride. The brands of Ceylon and Indian tea available in New Zealand contain from 90 to 150 ppm of fluorine, but the infusion contains only 0.5 to 1.5 ppm, depending on the brand and strength of infusion, and most of the fluoride is extracted in 5 minutes (Harrison, 1949b).

About ten cups of tea are necessary to give the amount of fluoride present in 1 quart of drinking water containing 1 ppm of fluoride. Tea is not a suitable vehicle for conveying fluoride to young children and its use is not recommended by authorities on nutrition.

178. In children of the same age, the consumption of fluids and of solid foods varies with factors such as climate, season, bodily development, degree of physical activity, and individual tastes. The data of Widdowson (1947) show great variation in the food habits of English children. Fluid consumption, however, is much more constant and is automatically regulated by physiological mechanisms. The daily ingestion of fluoride in the food and drinking water (1 ppm of fluoride) of American children is estimated as follows (Sognaes, 1954):

Age (Years)	Daily Fluoride Intake (Milligrams)		
	From Water	From Food	Total
1-3	0.39-0.56	0.03-0.27	0.42-0.83
4-6	0.52-0.75	0.04-0.36	0.56-1.11
7-9	0.65-0.93	0.05-0.45	0.70-1.38
10-12	0.81-1.17	0.06-0.56	0.87-1.73

179. Water is the natural vehicle for conveying the major part of the fluoride to the body. The amount of fluoride obtained from water depends not only on the volume of water consumed in drinking, but also on the amount used in cooking and, in the case of infants, on the method of preparing bottle feeds (Schlesinger & Ast, 1957).

180. Most New Zealand children will receive from natural drinking waters less than one-fifth of the fluoride contributed by water in the American estimates. As the amount of fluoride ingested from food sources is such a small proportion of the total, these children have little chance of obtaining the amount of fluoride needed for the proper formation of teeth, i.e., about 0.5 milligram per day up to 3 years of age and about 1 milligram per day from 3 to 8 years and onwards.

181. The ordinary mixed solid diet of adults will probably contribute about 0.3 to 0.5 milligram of fluoride daily (McClure, 1946). Pilot surveys conducted by the Ministry of Health in England give average figures for daily consumption of water, milk, and beverages, including tea and beer. Using these figures, and assuming that the domestic water supply contains 1 ppm of fluoride, it can be calculated that the average daily intake of fluoride would be about 3.2 milligrams for men and 2.2 milligrams for women (Longwell, 1957).

182. The heavy consumption of tea in New Zealand is a special consideration. Evidence on this point is available in the observations of Harrison (1949e) who measured the daily excretion of fluoride in the urine of 79 New Zealand subjects whose diet included tea. The average excretion was 0.50 milligram of fluoride per day. When 28 of the subjects abstained from tea the average daily excretion of fluoride was 0.27 milligram. These figures reflect the total fluoride intake but do not estimate it completely. However, if the domestic water supplies were fluoridated to the level of 1 ppm, it is unlikely that the heaviest tea or beer drinker would ingest more than 4 to 5 milligrams of fluoride daily.

183. *The Excretion of Fluoride*—Ingested fluoride is readily absorbed into the body unless the calcium content of the diet is high (Largent, 1954). It is, however, excreted rapidly by the kidney and, in addition, a small amount is eliminated in the sweat. Excretion in sweat becomes significant under excessively hot or humid conditions.

184. The normal kidney has the ability to excrete amounts of fluoride greatly in excess of those likely to be encountered in fluoridation, e.g., concentrations exceeding 40 ppm have been recorded in the urine of persons exposed to the industrial hazards of fluoride. The kidney responds rapidly to increased intake of fluoride as is shown by the fact that one-third of an oral dose of 1.5 milligrams of sodium fluoride is excreted in three hours; and the process of excretion of fluoride ions appears to be selective, the kidney removing fluoride ions from the blood more readily than bromide or chloride ions (Hodge & Smith, 1954).

185. Recent experiments with animals given radioactive fluoride confirm these observations (Hein, Bonner, Brudevold, Smith, & Hodge, 1956).

186. When the body is permanently exposed to a fairly constant intake of fluoride, it tends to a state of balance in which the concentration of fluoride in the urine becomes approximately equal to that in the drinking water when the latter contains 0 to 4.5 ppm of fluoride (McClure & Kinser, 1944; Zipkin, Likins, McClure, & Steere, 1956). This is an important fact in relation to the fluoridation of drinking water to the level of approximately 1 ppm.

187. The capacity of the kidney to deal rapidly with surplus fluoride ions is a powerful safeguard against the risk of any damage to the body following ingestion. The other safety mechanism is the storage of small quantities in the skeleton hidden away there from the blood and soft tissues. This is considered in the following section of this chapter.

188. *Storage of Fluoride*—There is no doubt that inorganic fluoride is a normal constituent of bone where it forms part of the structure of the mineral substance as it does in teeth. It appears to us to be established

that when excess fluoride is ingested any portion which is not rapidly excreted is deposited in the bones and thereby the concentration in the blood and soft tissues is kept automatically at a very low level.

189. The rapid excretion of most of the surplus fluoride and the deposition in the skeleton of part of that surplus prevents any adverse effect upon the bodily functions dependent on enzymes which are the agents that promote chemical change in the body. This storage of fluoride is slow in comparison with the rate of urinary excretion, and is reversible. Hence a reduction in daily intake of fluoride can be followed by elimination of part of the stored fluoride.

190. The fluoride content of bones appears to increase with age (Glock, Lowater, & Murray, 1941) and balance studies (Largent & Heyroth, 1949; Machle & Largent, 1943) provide indirect evidence for the view that the human subject stores fluoride in the bones even when the intake is at a low level (3 milligrams per day). However, these experiments showed that there was a progressive decrease in storage with the passage of time: 34 per cent of the fluoride absorbed weekly at the rate of 3 milligrams per day was stored in the initial 4 weeks, but the average weekly store diminished to 18 per cent in the final 8 weeks of an experiment lasting 45 weeks. This is consistent with the findings of Krylova & Gnoevaya (1956). On the other hand, the balance studies of McClure, Mitchell, Hamilton, & Kinser (1945) on five young men showed no detectable storage of fluoride so long as the amount of fluoride ingested daily did not exceed 5 milligrams per day.

191. In another investigation there was a prolonged excretion of fluoride in the urine, indicating depletion of the bone stores, when human subjects ceased to ingest fluoride (3 milligrams per day) which had been administered regularly for periods up to 130 weeks (Largent, 1952). A similar effect was seen when a person moved from a district where the fluoride content of the drinking water was high (Amarillo, Texas, 4 ppm) to one where the fluoride content was low (Cincinnati).

192. Dr Muriel Bell expressed the view at Hastings that the fluoride ingested daily up to a level of 4 to 5 milligrams per day was eliminated from the body in about 24 hours once a state of balance had been reached. In Dunedin she explained and enlarged on this earlier statement and provided certain reports indicating that some retention of fluoride occurs at low levels of intake. There is no doubt of the storage in bones when excessive amounts of fluoride are ingested by animals or humans and, although the experimental evidence is not conclusive, we regard it as likely that some retention of fluoride occurs at all levels of intake. It is necessary to add, however, that we are satisfied that there is no storage of fluoride in the soft tissues.

Conclusions Regarding Intake of Fluoride

193. Our conclusions in regard to the ingestion and storage of fluoride by the body are:

- (1) Fluoride is a normal constituent of human diet and in fact no diet is completely devoid of this element.
- (2) The principal source of fluoride is drinking water in all normal circumstances.
- (3) Fluoride is a normal constituent of the bony structure of the body and of teeth.

- (4) It is absorbed easily, but since most of the fluoride absorbed is rapidly excreted by the kidney, or readily deposited in bones, it does not impair the activity of enzyme systems.
- (5) Storage in the bones is a reversible process, although it is likely that some retention occurs at all levels of intake.

CHAPTER 22: THE TOXICITY OF FLUORIDE

194. Since no distinction can be drawn between ions of fluorine, whatever their origin, a consideration of the levels at which fluorine would have toxic effects on the human body will apply equally to fluoride derived from minerals in the earth, from natural waters, from a fluoridated water supply, or from the laboratory. We have stated in paragraph 193 our conclusions that fluoride is a normal constituent of diet and plays a part in the formation of the bones and teeth. We have stated also that it is absorbed easily, is excreted rapidly, and that traces of it are stored away in the bones. Against the background of these conclusions we turn to a determination of the point at which it becomes poisonous to the human organism.

195. It is evident that all foodstuffs, including water, can become poisonous in excess, and this principle applies to many substances beneficial or even essential to the human body when used in proper quantities. Such substances have beneficial or toxic effects, depending upon the amount ingested or the concentration of the substance in the body over a period of time.

196. This matter is discussed at length in the evidence of Dr Muriel Bell. She said:

It is natural enough to be afraid of a substance that is not only highly reactive, but is known to be capable of accumulating. I shall now proceed to show that there are many substances taken into the body that are highly reactive and can accumulate, but are nevertheless needed in small amounts for its proper functioning. People take such substances into their bodies every day; but in the amounts that are customarily eaten, these substances act in a beneficial manner.

Using vitamin A and vitamin D as examples, Dr Bell showed that minute amounts of these substances are needed to promote health and that human beings suffer from specific vitamin-deficiency diseases if the intake is too small, e.g., rickets in deficiency of vitamin D and disorders of the eyes, skin, and skeleton in vitamin A deficiency. These disorders may be cured by supplying quantities of vitamin considerably greater than the traces required to prevent the specific deficiencies. If these vitamins are taken in still larger amounts, they are poisonous and even fatal. Excess of vitamin A produces bone damage and excess of vitamin D causes abnormal calcifications. In the case of vitamin D the difference between the preventive and the poisonous doses is relatively narrow. As Dr Bell said: "One can have too much of a good thing"; and this applies to all foodstuffs.

197. Dr Bell's opinion is supported by Jolliffe (1956); according to circumstances, dosage, and manner of use, a single substance can be (1) a nutrient, (2) a medicament, or (3) a poison. There can be little argument about the validity of these views.

198. In the case of fluoride, we are satisfied that it has beneficial properties and when used in a proper way it is a nutrient. We state this conclusion in more detail in Chapter 23, which follows. The fact remains that both advocates and opponents of fluoridation have advised us that in excess fluoride is poisonous. As is the case with certain other substances, this arises:

- (a) In regard to excessive doses causing acute poisoning; and
- (b) Following chronic overdosage resulting in an unhealthy accumulation of fluoride in the body.

199. *Acute Poisoning*—We are satisfied that it is impossible to ingest a lethal dose of fluoride, or a non-lethal dose capable of producing the symptoms of acute poisoning, by consumption of water containing 1 ppm of fluoride. A *retained* dose of 5 to 10 grammes of sodium fluoride probably would be fatal in a human adult. But this lethal quantity would be contained in 550 to 1,000 gallons of water, all of which would have to be swallowed in a few minutes to have that lethal effect. Similarly, vastly greater quantities of fluoridated water than any person could drink would be required to produce acute non-lethal poisoning.

200. These facts make it plain that overdosing of water supplies would have to be on a huge scale before acute poisoning could result from drinking the water. We are satisfied that the mechanics of a properly designed fluoridation plant make it impossible for sufficient fluoride to enter a reticulation to cause acute fluoride poisoning. For this reason, this matter would require no further consideration were it not for certain highly coloured descriptions of fluorine published in various pamphlets.

201. Some of the *organic* compounds of fluorine are extremely poisonous substances, e.g., fluoroacetate, which has been used in rat poisons, and the organic fluoro-phosphorus compounds, the so-called "nerve gases" or "madness gases", which are potential weapons of gas warfare. Although these poisons have no relationship whatever to the fluoridation of water supplies, they are mentioned in anti-fluoridation pamphlets and in verbal evidence submitted by some of the opponents of fluoridation. The object of this propaganda is seemingly to confuse, mislead, and frighten the public with the false implication that fluoride is a poison comparable with these deadly compounds of fluorine. Dr Maud Fere, Dr Eva Hill, and Madam Mira Louise were all asked whether their object in using such expressions was to frighten people, and in one form or the other they agreed that this was the position.

202. In one pamphlet it is implied that fluoroacetic acid may be formed in fluoridated water. The following statement, copied from an American publication, appeared in a pamphlet *Fluoridation Facts* published by A. Wilkinson of Christchurch:

PROFESSOR R. A. PETERS: Bio-chemist of Oxford, England says: "Fluoroacetic acid prevents the body from breaking down the citric acid created when sugar is burned into simpler compounds. Retention of waste citric acid acts as a VIOLENT POISON on heart and nervous system. Fluoroacetic acid is used by African natives to murder their enemies. What will happen to the person drinking fluoridated water when he uses vinegar (acetic acid)?"

203. The fact that this is an absurd misrepresentation of the researches of Sir Rudolph Peters, formerly Professor of Biochemistry at Oxford, was explained by Mr Francon Williams, Assistant Director of the Dental

Division, Department of Health. He referred us to a letter written by Sir Rudolph Peters and published in the *Lancet*, 26 January 1957, as follows:

FLUORIDATION: A MISQUOTATION

Sir,

In a pamphlet from California entitled *Fluoridation Unmasked* the following statement about myself appears:

Professor R. A. Peters, Biochemist of Oxford, England says:

“Fluoroacetic acid prevents the body from breaking down the citric acid created when sugar is burned into simpler compounds. Retention of waste citric acid acts as a violent poison on heart and nervous system. Fluoroacetic acid is used by African natives to murder their enemies. What will happen to the person drinking fluoridated water when he uses vinegar?”

I do not know upon what writing of mine this is supposed to be based, but I think it as well to point out that it gives entirely the wrong impression. Inorganic fluoride acts completely differently in the body from fluoroacetic acid, in which the carbon is linked firmly to the fluorine. The suggestion in the last sentence that fluoride and acetic acid will combine easily to form fluoroacetic acid is very wide of the truth. It is in fact quite difficult to synthesise fluoroacetic acid, and certainly there is no evidence that it can happen in the body. Furthermore, acetic acid (vinegar), if given early enough, is an antidote to fluoroacetic acid poisoning in some animals.

R. A. PETERS,
A.R.C. Institute of Animal Physiology
(Biochemistry Department),
Babraham, Cambridge.

204. In September 1956, Dr G. N. Davies, Otago University Dental School, wrote to Sir Rudolph Peters drawing his attention to the fact that this assertion had appeared in this anti-fluoridation pamphlet. In his reply to Dr Davies dated 1 October 1956, Sir Rudolph Peters stated, *inter alia*:

Thank you for your letter of 19 September. I am astonished at this statement attributed to me, and should be most grateful to have the address of A. Wilkinson so that I can ask him for a reference. I have never said that “retention of waste citric acid is the cause of poisoning”. It is not fluoroacetic acid which is used by African natives in the Sierra Leone region. The last sentence in the quotation is meaningless.

205. This evidence is quite conclusive. The statement contained in the pamphlet which indicates that the extract is in the words of Professor R. A. Peters is untrue and the extract itself is a garbled misrepresentation of the facts. Mrs Amy Wilkinson herself appears to recognise this following a communication from Sir Rudolph Peters on the subject. She did not appear before us during our public sittings but, by letter dated 28 March 1957 addressed to the chairman of this Commission, she explained that the extract was copied from a booklet *Fluoridation Unmasked* by Fanchon Battelle. She concluded by saying that Sir Rudolph Peters “clears me personally in the matter but I shall probe further and try and find out where this information stemmed from originally”.

206. We regret the fact that inflammatory descriptions of fluorine are used in the various pamphlets to which we have made reference. They have no relation to the fluoridation of water supplies and may well mislead members of the public.

207. *Chronic Fluoride Poisoning (Fluorosis)*—The undisputed harmful chronic effects of fluoride in man and animals have been mentioned by witnesses on both sides. The details of the condition called “fluorosis”, and the level of fluoride intake at which it occurs, are described in the

evidence of Dr Muriel Bell and in the exhibits submitted by her; and Dr Roche also referred to the condition. Some witnesses opposed to fluoridation have been aware of the symptoms of "fluorosis", but none has attempted to define the level of fluoride intake at which it becomes manifest.

208. Since fluoride is stored in the bones, changes in bone and associated structures are features of chronic poisoning. A comprehensive description of fluorosis is to be found in the classical monograph of Roholm (1937) which we have had the advantage of considering in detail. Roholm studied the disorder in Danish cryolite workers who inhale fluoride-bearing dust, and in animals kept on diets to which known amounts of fluoride were added. The quantity of cryolite (sodium aluminium fluoride) inhaled daily by the persons investigated was equivalent to 70 milligrams of fluoride. It was calculated that the workers absorbed about 15 milligrams of fluoride per day. The chief features of the disorder were gastric symptoms and increased density of bone (revealed by X-ray and, in a few cases, by post-mortem examinations of persons who died from intercurrent causes), especially in the spinal column, the pelvis, and the leg bones. Abnormal calcification occurred in ligaments and tendons associated with the spinal column. Thirty-five of the 68 workers examined had some restricted mobility of the spine, ranging from slight stiffness in the lower spine to complete rigidity of the entire spine referred to medically as "poker back". The duration of exposure to cryolite dust was 9 to 21 years.

209. Referring to health generally, Roholm states:

There is nothing to show that workers acquired microscopically recognisable organic lesions apart from the bone changes.

210. Another comprehensive investigation of industrial fluorosis was conducted near Fort William, Scotland (Medical Research Council Memorandum, No. 22, 1949), at the site of two aluminium factories. Factory workers, the human population within range of fluoride-bearing fumes and dust, and the nearby farm animals were examined. A feature of the examinations was the absence of disabling symptoms, although a proportion of furnace men complained of cough and digestive symptoms. The furnace-room workers, with an average urinary excretion of 9 milligrams of fluoride daily, were exposed to the greatest hazard. The excretion of fluoride indicates that the intake was at least 10 milligrams per day. Abnormalities permitting the diagnosis of skeletal fluorosis were found by X-ray examination in some of the older workers, but the changes did not approach the severity of those seen in cryolite workers, and stiffness of the spine was not encountered. Livestock feeding on heavily contaminated herbage showed much more severe fluorosis than the human subjects.

211. Hodge & Smith (1954) have reviewed experiments which demonstrate that growth is retarded in many species of animals if sufficient fluoride is added to the diet (50 ppm under some conditions but usually 100 ppm or more).

212. Cases of skeletal fluorosis with "poker back" have been reported from some parts of South Africa where potable waters contain at least 11 ppm of fluoride (Ockerse, 1941). Reports from southern India and China described skeletal changes, sometimes accompanied by disability, which are attributed to fluorosis brought about by prolonged exposure

to potable waters containing from 2 to 12 ppm of fluoride (Short, Pandit, & Raghavachari, 1937; Pandit, Raghavachari, Rao, & Krishnamurti, 1940; Siddiqui, 1955; Lyth, 1946). In some of these regions climatic conditions encourage a high consumption of water, contamination of food with fluoride-bearing dust is possible, and there are associated degrees of malnutrition which may increase susceptibility to chronic fluoride poisoning. For lack of the necessary data these observations have not been evaluated in terms of actual fluoride intake.

213. It is evident, of course, that the establishment of the optimum level for fluoride concentration in drinking waters is a matter of importance. It is well established that atmospheric temperature and humidity have a considerable bearing on the amounts of water consumed in different places. In paragraph 116 we refer to a letter forwarded by Professor H. V. Smith to Mr Woodhouse on 13 March 1957. Dr Smith and his wife, Dr M. C. Smith, have been pioneers in the study of dental fluorosis in the United States. In his letter Dr H. V. Smith has described the fact that the threshold level at which mottled enamel would be produced in the teeth of children has now been established by them in several climatic zones in the United States. He included a table which showed, for example, that at Newburgh, with a mean annual temperature of 50.3°F . and a mean annual rainfall of 37.13 in., the threshold level is established at something over 1.2 ppm. On the other hand, at Yuma, Arizona, the threshold level is established at between 0.4 and 0.5 ppm. In this case the mean annual temperature is 72.2°F . and the mean annual rainfall 3.38 in. Dr Smith has also expressed his opinion in a letter to Dr Davies, dated 28 September 1956, that in places where the mean annual temperature is 59°F . mottled enamel will not develop from water containing 1 ppm of fluoride. The fixing of this threshold level takes into account the varying amounts of water consumed by different individuals in a given community. The suggestion made by Dr Eva Hill (*Hastings Address*, page 2) that "the dosage being tied to water consumption is quite incalculable" is unsupported by any evidence and we are satisfied that all the knowledge required for the fixing of the optimum level is available.

214. After considering all this evidence we are quite satisfied that the recognised forms of chronic fluoride poisoning are produced only by the regular ingestion over many years of fluoride at a much greater level than the total quantity of fluoride in food, water, and beverages that would be ingested if fluoridation were introduced in New Zealand.

215. The fact that chronic poisoning, as the name implies, arises only by the regular ingestion of considerable overdoses over such a prolonged period, rules out on the grounds of common sense the possibility that the overtreatment of water supplies could be a cause. Before fluoridated water could cause chronic fluorine poisoning, the proper supply of fluoride to be added to the water would have to be regularly multiplied several times over and for years on end. For these reasons it is established beyond doubt that there is no risk of chronic fluoride poisoning in the proposal to fluoridate water supplies.

216. Before adding our conclusions in regard to the toxicity of fluoride we refer to certain general allegations that fluorine is "a protoplasmic poison" or an "enzyme poison". General statements of this kind were made on many occasions during the inquiry. The first of

these statements appears to us to be dependent on the second or very largely so. It is well known that fluoride is used as an inhibitor in many biochemical studies and its properties in this respect are well understood. In this connection its effects are reversible. Dr Muriel Bell explained, however, that the concentrations used in such studies to produce significant inhibition or "poisoning" of enzymes are at least twenty times the concentration present in the body fluids and tissues of persons consuming fluoridated water. We are satisfied that there is no possibility of harmful inhibition of enzymic action as the result of consuming water fluoridated to the extent of 1 ppm. Professor R. S. Harris, who is often quoted by opponents to fluoridation in connection with the poisoning of enzymes, wrote to Dr C. N. D. Taylor on 28 May 1954 as follows:

I know of no reliable evidence that 1 part per million of fluorine is definitely toxic to human beings.

Conclusions as to the Toxicity of Fluoride

217. In summary, our conclusions in regard to the toxicity of fluoride are:

- (1) Fluoride is beneficial in proper doses and the optimum level in drinking water can be established with certainty.
- (2) In common with all foods including pure water, it can become harmful in substantial overdoses.
- (3) Acute or violent reactions could be produced only by such huge overdoses that the possibility becomes irrelevant in relation to the fluoridation of water.
- (4) In the proposal to fluoridate water, there is no risk of chronic fluoride poisoning.
- (5) The suggestion that fluoride is an enzyme poison has no relevance to fluoridated water.
- (6) The implication contained in certain anti-fluoridation literature that fluoridation involves the use of a substance with properties similar to certain deadly organic compounds of fluorine, is absurd and entirely misleading.

CHAPTER 23: IS FLUORIDE A MEDICAMENT?

218. We refer in paragraph 197 to the fact that according to circumstances, dosage, and manner of use, a single substance can be (1) a nutrient, (2) a medicament, or (3) a poison. We have stated in the preceding paragraph that the third of these alternatives is eliminated because fluoride becomes a toxic substance only at levels much above those relevant to any process of fluoridation. We have also expressed our conclusion in that paragraph that at levels relevant to the fluoridation process it is not harmful in any of the respects suggested by opponents of fluoridation or otherwise. It is desirable, however, to consider whether it should be defined as a nutrient or a medicament because of the view which has been stated before us by very many witnesses that fluoridation is a method of *medicating* communities.

219. The term "mass medication", is frequently used in anti-fluoridation propaganda entering this country from overseas. The term was adopted by many witnesses who regard fluoride as a drug and object

to the process on the ground that it is compulsory unethical interference with the relationship between the patient and the physician whose duty it is to prescribe for the individual patient.

220. This argument depends upon the meaning of the word medication. In general the witnesses claiming that fluoridation was a means of medicating the public did not attempt to define the word medication. Mr Jordan, however, went to *Chambers Twentieth Century Dictionary* for the following definition of medicine which he quoted before us:

Medicine – anything applied for the cure or lessening of disease or pain whether simple or compound.

When he invited Dr Davies to agree that fluoride came within this definition the latter replied:

I submitted on Friday, and I say again, that fluorides do not cure dental decay. They merely prevent it. Now, it is drawing, in my view, a very fine line to say that fluoride could be classed as a medicine under your definition because it lessens pain. It lessens pain, perhaps, because it prevents the disease but the pain is caused by the disease and you would reduce pain by treating the disease, which fluoride, in my opinion, does not do.

221. In our view, the definition adopted by Mr Jordan implies some *existing* disease or pain which an application of the medicine is designed to alleviate. But, taken literally, the definition is an extremely wide one. It appears to us to be a definition not of a medicament (or medicine) but of the whole art of medicine. It would include the application of physiotherapy, psychotherapy, preventive treatment such as the use of prophylactic vaccines and anti-sera, and food fortifications; and, indeed, the taking of food itself. We would agree that vaccines and anti-sera are medicaments in a preventive sense lessening disease, and also that the distinction between food and medicine could be reduced to vanishing point in a philosophical discussion. It could be argued, for example, that food was used as a medicine in the case of a starving man. We think, however, that in the common understanding of words there is a clear distinction between food and medicine.

222. Cushny (1924) has defined a drug as “a substance which is employed to counteract the effects of disease or to reinforce the tissues in their struggle to maintain their functions *when these are rendered abnormal*”. *Webster’s Dictionary* defines “medicine” as “any substance administered in the treatment of disease; a remedial agent”. The *Oxford Dictionary* defines the word “medicate” as the process of administering remedies. And very recently, the Lord Chief Justice of England stated that “a drug means what I might for convenience call a medicament or medicine – something given to cure or alleviate or assist an ailing body”. (*Armstrong v. Clark* (1957) 41 Cr. App. R. 56). We adopt these definitions. They appear to us to be entirely in accord with the layman’s ideas on the subject and we are satisfied that most people regard a medicament as a substance used in curative treatment.

223. Against this understanding of medication, we proceed to examine the various arguments that fluoridation does or does not involve a means of treating people in the mass without their consent. Supporters of fluoridation have stated that the term “mass medication” is a misnomer. They pointed out that fluoride is *not* used to *treat* dental decay but to *reduce the incidence of the disease*. This fact was not disputed. According to them, the process consists of adding to water, which no one has

disputed is itself a food, a sufficient amount of another food substance (fluoride ions) already naturally present in it to raise the total concentration to the optimum nutritional level. On this reasoning, they have argued that the process is food fortification completely analogous to examples mentioned in the evidence of Professor Gregory and Dr Muriel Bell and referred to in the following paragraph.

224. Well recognised examples of food fortification are the addition of calcium carbonate to "national flour" in Great Britain, the compulsory addition of vitamins A and D to margarine in Great Britain, the compulsory nutritional enrichment of bread and flour with B-group vitamins in some parts of the United States, the addition to some salt of iodide and the addition of synthetic vitamin C to a lemon-flavoured powder used by the New Zealand Navy. The addition of trace elements to the soil for the benefit of animals (e.g., the addition of cobalt to deficient pasture to combat bush sickness in sheep or cattle) or of plants (e.g., the addition of boron, manganese, molybdenum, or zinc to deficient soils) are examples of the way in which food deficiencies are supplemented in these cases for animals or for plants.

225. At the concentrations under discussion, fluoride is not a poison and is either a drug on the one hand or a food on the other. There is no doubt that it is beneficial to the human body just as the substances mentioned by Professor Gregory and Dr Bell are beneficial. It is certain, however, that it neither "counteracts the effects of disease nor reinforces the tissues in their struggle to maintain their functions when these are rendered abnormal". It does not counteract the effects of dental decay nor does it assist the teeth to maintain their functions after they are decayed.

226. We are satisfied that the process by which fluoride achieves its beneficial result is that a trace of the substance is utilised by the active tissues of the tooth germ as a foodstuff while they are forming the mineral substance of the tooth. Any effect subsequent to eruption of the tooth is an incidental ion-exchange at the surface exposed to drinking water.

227. Some authorities (see for example the evidence of Mr Needham (9J3)) regard fluorine as an indispensable trace element in the diet, whereas others question its indispensability but do not categorically deny that it is a food. (Mitchell & Edman, 1953; McLester & Darby, 1952). None, however, questions the usefulness of dietary fluorine to civilised man in reducing susceptibility to dental decay, and the evidence has shown that the usefulness of fluoride arises from its incorporation into the organised structure of tooth enamel (para. 74). In this regard, therefore, we consider that whatever academic discussion may revolve around the question of indispensability, it is certainly no less than common sense to make use of the beneficial properties of this trace element. If the intake is insufficient the deficiency should be made up in imitation of nature by fortification of the drinking water (cf. Waldbott, 1955 a).

228. For the foregoing reasons we express our conclusion that fluoride is not a drug but a nutrient and that fluoridation is a process of food fortification. As a process it is quite analogous to the compulsory addition of fat soluble vitamins to margarine, of vitamin B1 (thiamine) to bread, or the non-compulsory addition of potassium iodide to salt. For this reason there are no valid grounds for calling the process "mass

medication", a term which has acquired a certain emotional content in the course of controversy. In reaching this decision, we believe we are applying to the word medication the meaning most people attach to it.

229. We think it necessary to refer to an argument put before us by some supporters of fluoridation that chlorination of water supplies is a process analogous to fluoridation and that the former process is accepted universally. The comparison is directed to the fact that chlorination aims at the prevention of disease by destroying germs in drinking water while fluoridation aims at the prevention of disease by making the task of germs in the mouth more difficult.

230. We do not accept the view of supporters of fluoridation that these processes are analogous. In the case of chlorination this action takes place outside the human body, while in the case of fluoridation the substance is intended to strengthen the resistance of the teeth to the disease. The fact that each of the processes aims at preventing disease provides some similarity, but the methods by which this common aim is to be achieved are entirely dissimilar.

*Part V***COMPLAINTS THAT FLUORIDE IS HARMFUL TO HEALTH****CHAPTER 24: NATURE OF COMPLAINTS**

231. We have stated in paragraph 217 that there is no risk of acute or chronic poisoning arising out of the proposal to fluoridate water supplies. We come now to the more difficult question of assessing the alleged harmful effects of regularly ingesting the small quantities of fluoride of 5 milligrams per day and less which would follow fluoridation. There are many complaints made or anxieties expressed that fluoride, and particularly sodium fluoride, is the cause of a large number of illnesses. It is said that the long-term effects of fluoridation on the human body have been studied inadequately and cannot be known until investigations have been conducted for 30 or 40 years. Other witnesses have claimed that the relevant scientific evidence already exists. The main dispute over medical questions has arisen in this connection

232. Some criticisms have been directed to specific illnesses or diseases while others have been an expression of general uneasiness based on fear of the unknown rather than on directly observed facts. The following complaints are listed so far as possible in related groups and the evidence is considered in following paragraphs in the same way. It was alleged by opponents of fluoridation:

- (1) That fluoride promoted a progressively degenerative influence on nerve tissues, particularly the brain. That it had the tendency to affect that part of the brain concerned with volition and the will to resist. That it caused an increase in crime. That it is a nerve poison and caused intracranial lesions. That it made the use of Salk Vaccine dangerous and caused poliomyelitis. That it caused glaucoma and degenerative diseases of the eyes and even total destruction of the eyes. That it caused deafness for a period.
- (2) That fluoride caused heart diseases and arteriosclerosis.
- (3) That persons already suffering from kidney disease would be made much worse.
- (4) That it accelerated the growth of cancer.
- (5) That it caused diabetes.
- (6) That it caused goitre by reason of its effect on the thyroid gland. That it had a specific action on adrenal glands causing patchy discolouration of skin. That it had a specific effect on the parathyroid glands.
- (7) That it would cause ulceration of the mucous lining of the mouth, stomach, and duodenum and that constipation was an early sign of fluoride poisoning. That it affected the liver.
- (8) That it affected pregnancy by causing abortions and dry labours or developmental defects in children.

- (9) That it could have serious effects on bone structure. That it caused arthritis and stiffness of the spine.
- (10) That it caused reactions including mental and physical inertia, loss of feeling in the fingers, loss of the use of limbs, dropping of small objects, cramps in the extremities, dry mouth, thirst, nausea, and skin troubles.

233. Most of the assertions are based on the views of certain overseas medical practitioners and other persons whose opinions have appeared in anti-fluoridation publications or in the report of the Weir Bill Committee, and most were included in the evidence of one or other of four medical practitioners practising in New Zealand as general practitioners. They were Dr Eva E. Hill, Dr Elizabeth C. Mudie, Dr Maud T. Fere and Dr Ulric G. Williams. In addition many other witnesses, some of whom held qualifications which are not registrable as medical qualifications, gave evidence before us to support the complaints.

234. The majority of the lay witnesses opposed to fluoridation had derived their information largely from anti-fluoridation propaganda; but there was a group of lay witnesses who appeared before the Commission in Hastings to describe signs and symptoms of ill health which they attributed to fluoridation of the Hastings and Havelock North water supply. We review this latter evidence in Chapter 43.

CHAPTER 25: RESULTS OF MEDICAL SURVEYS

235. In the course of the inquiry, the proponents of fluoridation have submitted a great deal of medical evidence concerning the matters listed in paragraph 232. In addition to Dr Bell, these medical witnesses included Dr E. H. Roche (physician), Dr J. L. Newman (specialising in geriatrics), Dr C. R. Burns (physician, and a member of the Nutrition Research Committee of the Medical Research Council), Dr J. D. Bergin (neurologist), Professor H. M. Carey (Head of the Post-graduate School of Obstetrics and Gynaecology at Auckland University College), Dr P. P. Lynch (pathologist and a member of the Medical Research Council and President of the New Zealand Branch of the British Medical Association), Dr H. D. Purves (director of Endocrinology Research, Medical Research Council), and Sir Charles Hercus (Professor of Preventive Medicine and Dean of the Faculty of Medicine, Otago University, and Vice-Chairman of the Medical Research Council of New Zealand). We proceed to consider their opinions and the evidence they produced.

236. The medical witnesses supporting fluoridation in effect argued from the general to the particular. They pointed to certain wide-scale studies which had been carried out with a view to ensuring that no harmful effects could follow fluoridation of water supplies. In addition they attempted to satisfy us in regard to specific complaints. The general argument is considered first.

237. *General Studies*—Medical questions arising from an excess of natural fluoride in a water supply were stated to have been studied very carefully over a period of ten years by the United States Public Health Service (Leone, Shimkin, Arnold, Stevenson, Zimmermann, Geiser, & Lieberman, 1954). The towns selected for comparison were

Bartlett (population 1,668) and Cameron (population 5,040) situated 25 miles apart in Texas. The fluoride content of the water supply is 8 ppm in Bartlett and 0.4 ppm in Cameron. It was argued that if prolonged consumption of fluoridated water were a cause of ill health, this effect would be apparent in the residents of Bartlett. In 1943, 237 persons, 116 in Bartlett and 121 in Cameron, were chosen at random from persons who had resided continuously in the respective towns for at least 15 years and submitted to medical, dental, X-ray, and laboratory examinations.

238. The *clinical investigations* included a search for evidence of arthritis, raised blood pressure, cataract, decreased acuity of hearing, occurrence of fractures, stones in the urinary and bile tracts, goitre, and abnormalities of the heart and blood vessels; the laboratory studies included examination of blood and urine. The examinations were repeated ten years later in 1953 on 109 individuals. In 1943 the ages ranged from 15 to 68 and about half the subjects were aged 55 years or over in 1953; by 1953 the average exposure to 8 ppm of fluoride in Bartlett was 36.7 years.

239. As expected, mottled enamel (dental fluorosis) was observed in all persons continuously resident in Bartlett from birth to the end of the period of teeth formation. In Cameron the single individual with dental fluorosis had been exposed to fluoride early in life. Otherwise, the only significant difference between the prevalence of abnormalities in the two groups of people was a slightly higher rate for abnormalities of the heart and blood vessels in Cameron, the low-fluoride town. Thus, it is said, there is no evidence that the high-fluoride content of the water supply is detrimental to the general health of persons living in Bartlett.

240. The results of *X-ray examination* of the same subjects have been described by Leone, Stevenson, Hilbish, & Sosman (1955). A significant number of Bartlett residents, but only 10 to 15 per cent of those exposed, showed increased bone density which was not deleterious; indeed, the authors suggested that the change may be beneficial in counteracting the softening of bone in old age. There was no resemblance to the gross bizarre effects described in cryolite workers; no unusual incidence of fractures, arthritis, spur formation, or interference with the healing of fractures; and no cases of "poker back" or associated functional disorders.

241. A woman aged 79, with a history of 52 years' residence in the high-fluoride area, died of a stroke after the 1953 examinations were completed. The X-ray examination during life had shown a moderate degree of increased bone density. Chemical analysis of bone obtained at post-mortem showed approximately six times as much fluoride as analysis of the same bone from individuals living in non-fluoride areas. There was no evidence that this person had suffered any disability due to accumulation of fluoride in the bones.

242. Another woman aged 84, with a history of 50 years exposure to 4 to 8ppm of fluoride, was in excellent health and an X-ray examination showed no evidence of increased bone density.

243. Comparing the results in 1943 and 1954, Dr Leone and his co-workers found "no clinically significant physiological or functional effects resulting from prolonged ingestion of water containing excessive fluoride".

244. In this connection Sir Charles Hercus produced a letter written to him on 8 March 1957, by Professor Sosman, Emeritus Professor of Radiology at Harvard Medical School, who happened to be in New Zealand at the time, Professor Sosman was a member of the team of investigators. His letter concludes:

In summary I would say that from my study of the material I would conclude that fluorine of 8ppm in the drinking water has no deleterious effect on the individual living in the area and drinking that water. In fact there may be a slight benefit in the sense that it keeps the bones from softening as the patients grow older.

There is some experimental evidence to support this opinion (Gabovich, 1956).

245. *Mortality Statistics*—Another method of approaching the general problem is to compare the vital statistics of low- and high-fluoride areas. Hagan, Pasternack, & Scholtz (1954) have analysed mortality statistics for 1949–50 in thirty-two American cities which are using water supplies with a fluoride concentration of more than 0·7 ppm. Each city was paired randomly with a neighbouring city, the water supply of which contained 0·25 ppm of fluoride or less. The total population in the sixty-four cities exceeded two millions. Death rates, adjusted for age, sex, and race, were calculated for all causes of death, cancer, heart diseases, cirrhosis of the liver, nephritis, and intracranial vascular lesions (e.g., stroke). There were no significant differences as the figures show:

Mortality Rates Per 100,000 of Population
(Adjusted for age, race, and sex by indirect standardisation)

<i>Deaths from</i>	<i>"Fluoride" Cities</i>	<i>Control Cities</i>
Heart Disease	354·8	357·4
Cancer	135·4	139·1
Intra-cranial lesions	111·5	104·8
Nephritis	21·9	26·9
Cirrhosis of liver	6·6	8·2
All causes	1,010·6	1,005·0

From Hagan, Pasternack & Scholtz (1954)

246. The mortality statistics compiled by the Department of Public Health of the State of Illinois provided a good evaluation of the effect on general health of small amounts of fluoride in drinking water (*Health Statistics Bulletin*, Illinois State Department of Health, Special Release No. 22, 1952). The conclusion is:

Mortality statistics show that there is no significant difference in the general death rates between areas where fluoride is present and those where it is absent. Similarly, there is no significant difference in the risk of death from specific diseases such as heart disease, cancer, nephritis, and diabetes.

247. In Great Britain the Ministry of Health (1956) has reported:

As an additional check, comparisons have been made in this country of vital statistics in high- and low-fluoride areas and the following rates have been studied: neo-natal and infant mortality rates; stillbirth rates; death rate from all causes; death rates from kidney diseases (nephritis and nephrosis); cancer (all forms); ulcer of the stomach; cardio-vascular diseases; cancer of the stomach; and cancer of the breast. In none of these were there any differences between high- and low-fluoride areas which could be interpreted as indicating any harmful effect on health, nor even a slight pointer to the need for any further studies to demonstrate this.

248. It was stated that there is no evidence that fluoride has an adverse effect on growth. McClure (1944) found that the average height and weight of high-school boys and military trainees from fluoride areas in the United States compared favourably with accepted standards; and no significant differences in height and weight were found in about 3,000 young male subjects grouped according to the fluoride content of the water supply which ranged from 0 to 1.8 ppm (McClure, 1946). There were no differences in the fracture experience of 4,000 young men which could be related to fluoride in drinking water.

249. A very comprehensive medical examination of children formed part of the long-term investigation of *artificial* fluoridation (1.2 ppm) at Newburgh in the State of New York. As in the dental study, the children of Kingston provided the "control". The results after 10 years were described by Schlesinger, Overton, Chase, & Cantwell (1956). An earlier report (Schlesinger, Overton, & Chase, 1954) gave full details of the medical examination. Originally 500 children residing in each city were enrolled (100 in each of the age groups under 1 year, 1 to 2, and 5 to 9 years and 200 in the age group 2 to 5 years). Subsequently, groups of infants were added in order to include children who had been exposed to fluoride during their foetal development. In all the numbers examined were 817 children residing in Newburgh and 711 in Kingston.

250. The clinical examination included: the medical history; general physical examination with special attention to the skin (oiliness, dryness, skin turgor, and other features), mucous membranes, hair and thyroid gland; measurement of weight, sitting height, standing height, and circumference of head and chest; visual acuity, visual fields, and the size of the blind spot were determined and the cornea and lens examined by means of the slit lamp; examination of the ear, nose, and throat; measurement of hearing acuity by means of the pure tone diagnostic audiometer; and assessment of physical development at successive examinations.

251. Laboratory tests included analysis of urine and examination of blood (haemoglobin concentration and blood-cell counts).

252. The X-ray examination paid special attention to the right wrist, both knees, and the bone density. In the final examination the lumbar spine was X-rayed. The knees and wrists were measured in order to ascertain the proper exposures.

253. As a result of this thorough study, "no differences of medical significance could be found between the two groups of children". There were no significant differences between the growth and development of the two groups of children, including skeletal maturation. The supporters of fluoridation contend that this study has shown conclusively that artificial fluoridation of the water supply does not harm the health of children and does not retard their development. This is in accord with the work of McCauley & McClure (1954) who examined radiologically 2,050 children ages 7 to 14 years living in three areas with fluoride water levels of 0.1 to 6.2 ppm and concluded that naturally occurring fluoride at a high level did not affect maturation of the skeleton.

254. Having given full consideration to the known facts about the physiology, biochemistry, and toxicology of fluorine and to all the general medical questions related to the clinical observations and vital statistics described above, Dr Muriel Bell said under cross-examination

that "under all known health conditions and at all ages there can be no harm to anyone in this country by consuming water fluoridated to 1 ppm". This is a very definite expression of opinion by a witness exceptionally well qualified to give it; and Sir Charles Hercus stated that he subscribed completely to the scientific facts which were outlined by Dr Bell in her statement.

255. We turn from this general endorsement of fluoridation and the evidence produced to support it, to the specific matters outlined in paragraph 232. These are considered under their appropriate groupings.

CHAPTER 26: DISORDERS OF THE NERVOUS SYSTEM, ORGANS OF SPECIAL SENSE, AND DISORDERS OF THE MIND

256. Complaints in relation to these matters are mentioned in paragraph 232 (1). Dr J. D. Bergin, a consultant neurologist, who had received training at the National Hospital for Nervous Diseases, Queen's Square, London, gave evidence on matters encompassed by his specialty. He said that even in acute fatal poisoning due to fluoride the prior lethal effect is not cerebral and quoted his authorities at page 9Q 2 of the record. Where chronic intoxication with fluoride has occurred, the concentration of fluoride in the soft tissues is not significantly raised, although the amount stored in the bones is increased (Largent, 1954). He expressed the opinion that, for these reasons, it is not to be expected that brain and other nervous tissues will show any ill effects.

257. There is no evidence that disturbances of brain or nervous function attributable to fluoride occur in populations known to consume water containing 0.9 to 5 ppm of fluoride. The studies of adults in Bartlett (Texas) and of children at Newburgh (New York) have not revealed any increased incidence of disease in brain or other nervous tissue.

258. Dr Bergin, who has also had considerable experience of mental diseases, said he was unaware of any evidence in medical literature or in his experience where fluoride was even remotely considered as a causal factor in mental disease. In view of these facts he considered that the consumption of water containing 1 ppm of fluoride can do no harm to the brain or other parts of the nervous system.

259. There is no evidence that cases of glaucoma or cataract, or cases of otosclerosis with deafness, can be attributed to the intake of water containing 1 ppm of fluoride (Leone *et. al.*, 1954; Lewy, 1944). Hearing acuity tests on the children of Newburgh and Kingston revealed no differences between the two groups.

260. *Mongolism*—This question was not introduced by any opponent of fluoridation giving evidence before us. It was brought to our attention in Dunedin by Dr Muriel Bell, who considered she should inform us of certain articles by Dr M. I. Rapaport (1956). He had claimed that dental decay is less prevalent in mongoloid children than in normal children of the same age fed on the same diet. Dr Rapaport studied the geographical distribution of mongolism in four States of the American Union and suggested that there is a positive correlation between the prevalence of mongolism and the fluoride content of the water supply.

261. Dr Bell submitted various exhibits pertaining to this work and they include correspondence from Dr A. L. Russell, National Institute for Dental Research, Bethesda, U.S.A., and from Dr W. T. C. Berry, Ministry of Health, London. Dr Russell states that Dr Rapaport, who is a Frenchman, made a systematic error in his statistics owing to his lack of acquaintance with the method of birth registration in the United States. When the data are corrected there is no correlation; Dr Russell gives very full reasons for the necessary corrections. Dr Berry's preliminary examination of the problem in England shows no indication to support Dr Rapaport's hypothesis.

CHAPTER 27: DISEASES OF THE HEART, BLOOD VESSELS, NEPHRITIS AND NEPHROSIS, CANCER, AND DIABETES

262. Some of these diseases are dealt with separately in following chapters. The complaints associated with them are to be found listed in paragraph 232 as items (2), (3), (4), and (5). The evidence of Dr Burns and Dr Roche dealt particularly with the questions raised and they referred us first to the Bartlett-Cameron study (see para. 238). This revealed no greater tendency to these diseases among persons living in Bartlett when the water supplied has contained 8 ppm fluoride; and Roholm (1937) found no evidence of an increased incidence of these diseases in cryolite workers who had developed occupational fluorosis. There is no evidence that consumption of fluoridated water increases blood cholesterol.

263. Dr Roche presented the statistics for death rates from cancer, diseases of the heart and blood vessels and of the kidney in Newburgh and Kingston during the years 1942 to 1954. There are considerable fluctuations in the mortality statistics of these two small populations, as might be expected, but the mean for the years 1942 to 1945 inclusive (prior to fluoridation in Newburgh) is not significantly different from the mean for the years 1951 to 1954 inclusive (after fluoridation). In the case of cancer the mean for the first period is 195.8 at Newburgh and 195.4 at Kingston: for the second period the mean is 221.7 at Newburgh and 237.1 at Kingston. The figures are as follows:

<i>Death Rate from Cancer</i>			<i>Death Rate from Cardio-vascular Renal Disease</i>		
<i>Year</i>	<i>Newburgh</i>	<i>Kingston</i>	<i>Year</i>	<i>Newburgh</i>	<i>Kingston</i>
1942 . . .	174.1	207.4	1942 . . .	737.6	741.7
1943 . . .	212.4	193.4	1943 . . .	872.0	865.0
1944 . . .	219.0	169.0	1944 . . .	860.0	848.5
1945 . . .	177.9	211.8	1945 . . .	832.1	896.4
1946 . . .	222.1	282.4	1946 . . .	818.7	776.6
1947 . . .	214.7	249.5	1947 . . .	741.8	892.6
1948 . . .	154.0	223.8	1948 . . .	877.0	744.9
1949 . . .	188.0	188.0	1949 . . .	865.6	807.8
1950 . . .	249.1	276.0	1950 . . .	887.3	282.1
1951 . . .	258.3	213.1	1951 . . .	834.1	893.5
1952 . . .	235.9	198.5	1952 . . .	735.7	828.3
1953 . . .	171.5	272.3	1953 . . .	851.2	847.7
1954 . . .	221.1	264.4	1954 . . .	741.4	796.7

264. The opponents of fluoridation have claimed that after fluoridation began in the city of Grand Rapids, the death rates for diseases of the elderly such as cancer, heart diseases, intracranial lesions, diabetes,

and arteriosclerosis became higher than the corresponding average death rates in the State of Michigan as a whole. In this connection a letter from Dr W. B. Prothro, Public Health Director, city of Grand Rapids, Michigan, dated 26 September 1956, to Dr G. N. Davies was made available to us. It reads:

You state that I have been quoted in the *Grand Rapids Herald* of 28 July 1955 as having said that the death rates from cancer, heart disease, intracranial lesions, diabetes, and arteriosclerosis have increased due to our fluoridation program. This is not a true statement. (Exhibit A1, 4P 1.)

After referring to statistics enclosed with the letter, Dr Prothro says:

In brief, we have not experienced any increase in death rates from any disease as a result of water fluoridation.

CHAPTER 28: KIDNEY DISEASES

265. Several individual questions have been raised in connection with the effect of fluoride on the kidneys (see para. 232 (3)). They are:

- (1) The suggestion that the kidneys are impaired by fluoride.
- (2) That kidneys already diseased would have that condition aggravated.
- (3) That the inability of diseased kidneys to excrete fluoride would cause harm to other organs.
- (4) That urinary calculi result from the ingestion of fluoride or that the presence of fluoride in the stones confirms the other allegations.

These complaints have been made by several witnesses including Dr Eva Hill. They were considered by Dr Muriel Bell, Dr Charles Burns, Dr Edward Roche, and other medical witnesses supporting fluoridation who described certain researches that had been made into the matter.

266. The study of urine specimens from about 100 boys aged 12 living at Newburgh for 8 years after the inauguration of fluoridation revealed no significant differences in albumin content, number of casts, and blood cells when compared with a similar group at Kingston where the water has a low-fluoride content (Schlesinger, Overton & Chase, 1955). No kidney disorder arising from fluoridation was discovered by these tests in the group of Newburgh children.

267. Dr Bell referred to experiments carried out with animals. Not until the concentration of fluoride in the drinking water had reached massive proportions in comparison with the fluoridation proposals could any harmful effects on the kidneys be observed. These concentrations were 100 to 500 times that recommended for fluoridation of water supplies (page 1X 2).

268. Roholm (1937) found no evidence of kidney damage attributable to fluoride in cryolite workers who regularly, over a period of 10 to 20 years, had been absorbing about 15 milligrams of fluoride daily, which is approximately seven times as much fluoride as would be contained in normal daily diets of persons with access to a fluoridated water supply. Dr Burns pointed out that the same finding was true of residents of Bartlett, where the natural waters contained 8 ppm fluoride.

269. *Effect of Fluoride on the Diseased Kidneys*—It was argued in this connection that fluoride would aggravate disease of the kidney and also that, as water containing 1 ppm fluoride would not be satisfactorily

eliminated from the body by the diseased kidney, the fluoride retained would produce harmful effects in other directions. In respect of these matters it is claimed that the drinking of naturally fluoridated water was the cause of one accelerated death in the United States and another in Argentine (Waldbott, 1955a, 1956) in patients suffering from kidney disease. (See paras. 272 to 274.)

270. Dr Bell stated that any diminished ability of the diseased kidney to excrete fluoride was irrelevant, because that organ, even when diseased, would deal satisfactorily with the substance until either the daily ingestion got to a level which has no relation to the fluoridation process or the kidneys were so damaged that death would follow, not from the effects of fluoride accumulating, but from kidney disease. Largent & Largent (1955) considered this question and reported that storage at an intake level as high as 6 milligrams per day "would not lead to accumulation of sufficient fluoride in the skeleton to affect adversely (patients with chronic kidney disease) even if continued over a period of 10 to 15 years".

271. The studies of Smith, Gardner & Hodge (1950) are relevant to the question of fluoride excretion in kidney disease. These workers have shown that fluoride is excreted in the urine by filtration through the glomerular part of the kidney without the need for active secretion by the tubular portion of this organ. This would make it easier for a damaged kidney to eliminate fluoride.

272. In her evidence (page 1X 2) Dr Bell said:

The evidence in human beings is that the fluoride content of the urine of seven nephritis patients increased with increased water intake; just as it does with non-fluoridated water, so it did with fluoridated water. Since the urine volume is frequently increased in chronic glomerular nephritis the data of these workers seems to suggest that in this type of nephritis the affected person is capable of excreting more fluoride in the urine than normal persons. The urine is diluted in such cases and the concentration of the fluoride ion will not be at a serious level.

Dr Roche confirmed this opinion.

273. Reference was made to allegations by Dr Waldbott (1955a, 1956) that two fatalities had followed the drinking of water containing low concentration of fluoride when the persons concerned were affected by kidney disease. Dr Waldbott stated these deaths were due to the retention of fluoride in the body.

274. One case (Linsman & McMurray, 1943) was a male aged 22 years who had lived for 13 of the last 15 years of his life in areas where the water contained 4.4 to 5.7 ppm fluoride. At the post-mortem examination one kidney had little if any functioning tissue, probably as the result of an injury at the age of 15 years, and the bones showed an advanced sclerosis. The other was that of a female aged 23 years who suffered from a gross congenital malformation (hydronephrosis of both kidneys) and showed marked change in bones (osteopetrosis). According to Dr Waldbott the water consumed by this person contained fluoride "at about 2 ppm *and above*".

275. These two cases which were examined at post-mortem exhibited gross kidney disease which was not caused by fluoride, and it appears that both consumed water with a distinctly higher content than 1 ppm

for a considerable period. In these circumstances, it is not surprising that fluoride may have accumulated in bone. It cannot be said, in our opinion, that death in either case was caused or accelerated by fluoride.

276. It has been stated that a reasonable conclusion from all these facts is that persons with sufficient kidney damage to result in fluoride retention at the 1 ppm level will succumb to kidney disease long before the retention is sufficiently advanced to be manifest (Wynne Griffith, 1957).

277. *Urinary Calculi*—Recent reports (Herman 1956; Spira, 1956) have recorded the presence of fluorine (from about 4 to 1,790 ppm) in urinary calculi. On the basis of this fact, Dr Spira (1956) has stated:

In the mechanism of formation of urinary calculi, fluorine ingested with practically every article of daily food and drink, seems in many cases to play a vitally important role.

The stones described by Dr Spira were composed largely of calcium combined in some cases with oxalate, in others with carbonate or phosphate. There was no satisfactory evidence of a correlation between the concentration of fluoride in the urine and the fluorine content of the stones. We do not think it is the least surprising that traces of fluorine originally present in the urine should have become concentrated in the solid phase of the stones as these crystallise slowly in the urinary tract. Dr Hill, who introduced this subject, accepted the view put to her by Mr Woodhouse that the presence of traces of fluorine in these stones does not infer that they were caused by the fluorine.

278. After considering all this evidence we are satisfied that the consumption of water containing 1 ppm of fluoride does not cause kidney disease or disease of the urinary tract. We do not consider the fatalities mentioned by Dr Waldbott to be related to fluoride. We agree with the conclusion "that persons with sufficient kidney damage to result in fluoride retention at the 1 ppm level succumb to kidney disease long before the retention is sufficiently advanced to be manifest". In our opinion, therefore, fluoride at any relevant level of ingestion will not adversely affect the kidneys or the body through kidney disease.

CHAPTER 29: CANCER

279. The opponents of fluoridation have alleged that fluoride is a cause of cancer or accelerates the growth of cancer (see para. 232 (4)). This has been described by other witnesses as a misrepresentation of the work of Dr Alfred Taylor, University of Texas (evidence of Colonel Fuller, R.2).

280. Dr Taylor described his experiments in evidence given before the Delaney Committee. He gave drinking water containing 4.5 ppm of fluoride to a strain of mice which develop spontaneous breast cancer. He said:

The results show no change in the incidence of cancer, but rather indicate a shorter life span in the mice receiving fluoridated water. In other words, if a mouse were destined to die of cancer, this disease developed earlier in the group receiving the treated water. . . ."

Under cross-examination, Dr Taylor revealed that the solid "chow" on which the mice were fed contained 38 ppm of fluorine, a fact which threw doubt on the interpretation.

281. Dr Armstrong and Dr Bittner, University of Minnesota, subsequently tested the effect of fluoridated drinking water (5 to 10 ppm) on the development of breast cancer in mice and found no acceleration of cancer growth.

282. After reviewing the laboratory and epidemiological evidence on the relationship between fluorides and cancer Dr Charles S. Cameron, President of the American Cancer Society, has stated:

The American Cancer Society does not consider fluorine or the common fluorine salts to be carcinogenic. Its position, therefore, with respect to water fluoridation for the purpose of dental caries prophylaxis, is that such treatment of public water supplies is without danger so far as cancer causation is concerned.

CHAPTER 30: DIABETES

283. Dr Eva Hill stated that fluoride "causes a breakdown in carbohydrate metabolism and a deficiency of vitamin B1 and is thereby concerned in the causation of diabetes". (See also para. 232 (5)). Fluoride has long been used as a selective inhibitor in studies of carbohydrate metabolism and its effects are well known in this regard. It does not affect the enzymes involved in carbohydrate metabolism at the concentration present in fluoridated water or in the blood and tissues of animals consuming fluoridated water.

284. We are satisfied Dr Hill's statement is relevant to experiments in which large concentrations of fluoride are used, but not to the conditions arising from the proposal at issue.

285. It has been alleged without cogent evidence that deaths from diabetes have increased as a result of fluoridation at Grand Rapids. Evidence relating to Illinois where mortality statistics have been recorded indicate that this allegation is groundless (see para. 246).

CHAPTER 31: GOITRE

286. On several occasions opponents of fluoridation have quoted Professor D. G. Steyn, Professor of Pharmacology in the University of Pretoria, and Dr Dagmar Wilson, Human Nutrition Laboratory, Oxford, as authorities to support the contention that fluoride is a cause of goitre. This complaint is mentioned in paragraph 232 (6).

287. The matter was discussed in detail before us by Dr H. D. Purves, a well recognised authority on goitre, who has conducted investigations on the thyroid gland continuously for 25 years. After discussing the causes of goitre, Dr Purves said:

It has been suggested that naturally occurring fluorides may be responsible for a high incidence of goitre in certain regions, but this view is not supported by recent investigations. It is not held by anyone that I know who is experienced in the field of thyroid disease. The reasons for thinking that fluoride does not play any part in the causation of goitre are:

- (1) That administration of fluoride to animals does not consistently produce any thyroid disturbance.
- (2) That regions of naturally high-fluoride intake are not noted for their goitre incidence.

(3) That industrial exposure to fluorides has not been observed to cause goitre.

In the studies which have been made by Roholm and also by the Medical Research Council in England, people who are known to have been receiving considerable amounts of fluoride over a long time have not shown any thyroid disease. Experimental studies have shown that fluoride does not interfere with the accumulation of iodide by the rat thyroid (Wyngaarden, Wright, & Ways, 1952). . . . It is not accumulated there as the iodide is.

After citing other studies (Williams, Jaffe & Solomon, 1950) Dr Purves said:

It is my opinion from reading these reports, and from some experiments I have made myself, that fluoride at the amount of 1 ppm in drinking water would not have any effect on the thyroid gland and would not alter the reaction of the thyroid gland to other influences.

288. Referring to publications by Dr Dagmar Wilson, Dr Purves said:

These papers refer to the alleged occurrence naturally of goitre among human beings in association with allegedly high-fluoride intake. Now, of course, this would be expected to occur. If one has regions scattered throughout the world with perhaps a high-fluoride intake, and quite independently there are regions of low-iodine intake, it is possible somewhere one will have a region which has goitre, and perhaps has high fluoride, but what we need to establish for a causative relation, is some general relation between high fluoride and goitre and not one specific district which might have such a coincidence. . . . I think I should also mention a later paper by Murray and Wilson did not find any relation between goitre and fluoride in a region where there was a known fluoride intake.

289. In regard to a paper by Professor Steyn, Dr Purves said:

I don't know who did the analyses and who was responsible for the logic, but there is no logical conclusion to be drawn from their observations. They have in this particular region in North Western Cape Province an area where there is endemic goitre and where the local water supplies vary in fluoride content; some are high and some are low, but one, of course, has no reason to deduce from that that it is the fluoride that is the cause of the goitre there. In fact they have in their children reported instances of goitre as high as 18 per cent in schools where fluoride was practically absent from the water; so I don't think that their observations support their conclusions that the fluoride is the cause of goitre in that region.

Mr Woodhouse asked for comment on the following extract from a publication by Professor D. G. Steyn in 1953:

It was recently established that small quantities of fluorine in drinking water suppress thyroid activities and in our fluorine areas endemic goitre is frequent.

Dr Purves gave the following reply:

Well, it appears that in their high-fluoride area there is goitre present and that, I think, is a coincidence, in that other high-fluoride areas in other countries do not have goitre. Was there another point there? Ah, yes, that it acted by suppressing thyroid functions. It does not do this in any acute experiments that have been made with animals, even in large amounts.

Dr Purves explained that uptake of radioactive iodine by the thyroid gland was the test implied by the expression "acute experiments".

290. Finally, Dr Purves declared that he was quite satisfied that fluoride at levels of 1 or even 5 to 10 ppm had no detrimental effect on the thyroid gland.

Thyroid is quite resistant to this particular substance.

291. The relation of fluoride to goitre is discussed by Wynne Griffith (1957), whose conclusions in respect of endemic goitre agree with those of Dr Purves.

292. In paragraph 232 (6) we mention that in addition to complaints that fluoride caused goitre it was alleged to have adverse effects on the parathyroid glands and the adrenal glands. These matters are discussed in paragraph 327 to 332 *infra*.

CHAPTER 32: EFFECTS ON MUCOUS MEMBRANES AND GASTRO-INTESTINAL SYMPTOMS

293. It has been asserted that fluoride affects the gastro-intestinal tract causing ulceration of the mucous membranes (see para. 232 (7)) and that fluoride irritates the eyes and causes irritation of mucous membranes of the bladder and urinary tract. This assertion appears to us to be based on the belief that undissociated hydrofluoric acid is the causative agent (Dr Hill). However, the addition of a fluoride to water does not give rise to any significant amount of undissociated hydrofluoric acid unless the water is acid to an extent which would render it quite unsuitable for domestic uses. The reaction of potable waters is close to neutrality either on the acid or alkaline side of this point, and within this range of variation virtually no hydrofluoric acid exists. Although the stomach produces a strongly acid gastric juice in which the fluoride ion will become largely converted into undissociated hydrofluoric acid, the contents of the intestine are not sufficiently acid to permit the existence of any significant amount of hydrofluoric acid. On referring to the literature (Bowie, Darlow, & Murray, 1953; Bond & Hunt, 1956) we find that the installation of sodium fluoride into the stomach of the anaesthetised cat has strongly inhibited the secretion of hydrochloric acid, an essential ingredient of gastric juice. The fluoride solutions used were nearly 100 times as concentrated as water containing 1 ppm of fluoride.

After considering these facts we have come to the conclusion that the amount of hydrofluoric acid that would be present in the stomach as the result of drinking fluoridated water would not injure the mucous membrane or inhibit the secretion of hydrochloric acid. This conclusion in respect of mucous membranes applies with even greater emphasis to the lower parts of the gastro-intestinal tract where the undissociated hydrofluoric acid concentration would be quite negligible.

294. Roholm states that cryolite workers commonly complained of nausea, vomiting; and loss of appetite on first exposure but soon became inured; and that "there was no indication that the state of nutrition suffers and sickness-absence from gastro-intestinal complaints was below the average for Denmark". At aluminium factories in Fort William, sickness absence on account of dyspepsia was rather lower among those exposed to the maximum risk than in other groups of workers less exposed. Here complaints of dyspepsia were not clearly related to the industrial hazard. In view of these facts we are satisfied that water containing 1 ppm of fluoride does not cause ulceration in the gastro-intestinal tract or produce symptoms of dyspepsia.

295. So far as the eyes are concerned we are satisfied that fluoridated water could not cause irritation of the cornea or of the mucous lining of the eyelids by reason of the fluoride that it contains. It is also clear that the acidity of urine is such as to preclude the existence of any significant amount of undissociated hydrofluoric acid in the urine. We

are satisfied that persons consuming water which contains 1 ppm of fluoride will not suffer irritation of the mucous lining of the bladder or of any part of the urinary tract by reason of the fluoride excreted in the urine.

CHAPTER 33: THE EFFECTS OF FLUORIDE ON PREGNANCY

296. Quoting Dr G. L. Waldbott, Mr Jordan stated that fluoride caused uterine bleeding; and Dr Eva Hill said, "In a pregnant woman fluorine can cause abortion or developmental defects in the child should the pregnancy reach full term". Anti-fluoridation pamphlets (e.g., *Fluoridation Facts* published by A. Wilkinson, of Christchurch, under the caption "Unborn babies are killed") quote the evidence of Dr C. T. Betts, a dentist, who testified before the Weir Bill Committee to the effect that fluoride caused dry labours. These complaints are referred to in paragraph 232 (8).

297. Further to the alleged effects on pregnant women, F. Battelle, author of a booklet called *Fluoridation Unmasked*, stated that army doctors in Colorado Springs (where the water contains 2.5 ppm of fluoride) advised pregnant wives of army personnel to drink non-fluoride bottled water. Dr C. N. D. Taylor produced documentary evidence, in the form of communications with the United States Army, to show that this particular statement is quite untrue and contrary to the thinking of the United States Armed Forces Medical Authorities, who in fact appear to have directed the use of fluoride at army posts where the fluoride content of the water is low and where there is a substantial child population.

298. The alleged harmful effects of fluoride on pregnant women and babies were discussed by Professor H. M. Carey, Professor of Obstetrics and Gynaecology at the Post-graduate School, Auckland University College. Gardner, Smith, Hodge, Overton, and Feltman (1952) have shown that placentas from women living in Newburgh (1.2 ppm fluoride) contained three times as much fluoride as those from women in Rochester (0.6 ppm fluoride), but this had no detrimental influence on mother or child. The statement that women in Newburgh were having dry births because the placentas contained three times as much fluoride as the normal placenta had no justification. The amount of amniotic fluid is unrelated to the fluoride content of the blood or placenta. During the period beginning 5 years before fluoridation was initiated at Newburgh and ending 10 years afterwards, the still-birth and infant mortality rates at Newburgh and Kingston (New York State) show similar trends, and there is no detectable change in these rates at Newburgh after fluoridation. The still-birth rate for the area of Sheboygan prior to fluoridation (1940-44) was 24.1 per thousand live births and 19.1 after fluoridation (1945-49). (The decrease is merely a trend which is seen in many parts of the world. In New Zealand, for example, the still-birth rate for 1939-43 was 27.6 and for 1944-48 it was 21.3.)

299. Summarising the position Professor Carey said:

The scientific evidence available shows that the ingestion of water containing 1 or 2 ppm of fluoride by pregnant women has no harmful effect on the mother or the baby, but it has a definitely beneficial effect and reduces the incidence of dental caries in the children.

CHAPTER 34: BONES, ARTHRITIS, AND ANAEMIA

300. Skeletal fluorosis has already been discussed by us in paragraphs 207 to 214, which deal with chronic toxicity. This condition which involves increased bone density in most cases is harmless and symptomless, although symptoms can arise with very prolonged exposure at high levels of ingestion. These conditions can lead to immobility of the spine and symptoms which may be described as arthritis. They are not relevant to the levels of fluorine under consideration.

It is necessary, however, to consider suggestions of a different kind which were raised by several witnesses (see para. 232 (9)).

301. Kemp, Murray, & Wilson (1942) reported that osteochondritis of the spine of the type described by Scheurmann was common in children living in Oxfordshire villages where the level of fluoride in the water ranged from 0.3 to 0.8 ppm. Although they were unable to correlate changes in the spine with the incidence of "mottled enamel", they interpreted the geographical distribution to mean that fluoride might be a cause of Scheurmann's disease when associated with malnutrition.

In considering this hypothesis, Dr Burns said:

There has been made available to me through the courtesy of Dr Muriel Bell a paper which is only now in the press (but a copy of which has been tabled) by Eley, Kerley (who is, of course, a most distinguished radiologist to the Department of Health), F. H. Kemp, and W. T. Berry who have reinvestigated this problem and whose findings are that fluoride present in drinking water varying from 1.5 to 5.5 ppm is not associated with a higher incidence of Scheurmann's disease or of any other spinal defects in British boys than prevails in comparable low-fluoride areas. Moreover, they are unable to show that there is any positive relationship between fluoride consumption, malnutrition, and spinal defects. As in the case of other workers who have drawn conclusions similar to those of Kemp, Murray, & Wilson (1942), the index of fluorosis has been mottling of teeth, but in all such cases the original observers had failed to take into account the fact that this condition of the teeth can occur independently of the effect of fluoride.

302. This matter was also the subject of a memorandum submitted by Dr Bell and included in the Wellington evidence. The memorandum is accompanied by several important exhibits including the whole of the correspondence on this subject which appeared in the *British Medical Journal*, 1955-56. We have considered all this evidence relating to the possibility arising of disease in the bones and joints and we are satisfied that the consumption of water containing 1 ppm has no harmful effects.

303. Dr H. M. Sinclair, Director of the Human Nutrition Unit at Oxford, is a colleague of Dr Dagmar Wilson, who is one of the authors of the paper mentioned in paragraph 301. He has been quoted frequently as a British scientist of note who is opposed to fluoridation. In a letter to the *British Medical Journal* (1, 1955, 284) Dr Sinclair and Dr Dagmar Wilson stated their position as follows:

Our argument is, in summary, that we do not consider it to be established beyond reasonable doubt that increasing the fluoride content of public water supplies to 1 ppm is without risk to adults in this country. We consider that more research should first be done, which should include further studies upon storage in the body, particularly of the elderly.

Dr Muriel Bell suggested to us in a lengthy memorandum submitted at Wellington that this cautious attitude on the part of Drs Sinclair and Wilson arises from the studies of the latter investigator and her co-workers. Dr Bell considered that Dr Dagmar Wilson's conclusions in

regard to the supposed relationship between the fluoride content of drinking water and the occurrence of Scheurmann's disease, endemic goitre, and mottled enamel were not valid. For the reasons we have given we consider that Dr Dagmar Wilson and her co-workers are not justified in their conclusions and it appears to us, therefore, that Dr Sinclair has been over-cautious in his assessment of the general situation.

304. *Anaemia*—Opponents of fluoridation have alleged that fluorine causes anaemia. If there is an interference with the physiology of bone, this is a plausible suggestion because bone changes might affect the blood-cell formation in the marrow. The supporters of fluoridation, however, state that Roholm (1937) examined the blood picture in cryolite workers who were, of course, ingesting much greater quantities of fluoride than are relevant to this inquiry. He reported that "on the whole the deviations from the normal were few and not very marked". Industrial fluoride exposure in Britain did not produce changes in the blood picture (Medical Research Council, Memorandum No. 22, 1949); nor were there any material changes in the blood of persons exposed to water-borne fluoride in the Newburgh-Kingston study (Schlesinger, Overton, & Chase, 1954) and in the Bartlett-Cameron investigations (Leone *et. al.*, 1954). Examination of thirty-two cases of skeletal fluorosis in India suggested that a mild degree of anaemia might arise from narrowing of the marrow cavity.

305. Since all the foregoing examinations were concerned with persons ingesting considerably greater quantities of fluoride than are relevant in a consideration of fluoridation we accept the view of supporters of fluoridation who state that the process can involve no risk of anaemia.

CHAPTER 35: SUMMARY OF CONCLUSIONS ON THE COMPLAINTS THAT FLUORIDE IS HARMFUL TO HEALTH

306. After full consideration of all the evidence we are satisfied that fluoridated water does not cause or aggravate any of the following disorders:

- (1) Disorders of the brain and nervous system, disorders of the special senses, and disorders of the mind.
- (2) Disorders of the heart and blood vessels.
- (3) Disorders of the kidney and urinary tract.
- (4) Cancer.
- (5) Diabetes or disorders of the thyroid gland.
- (6) Disorders of the gastro-intestinal tract and the liver.
- (7) Disorders of pregnancy and labour or developmental defects in children.
- (8) Disorders of bones, joints, and the bone marrow.
- (9) Irritation of the eyes or irritation of mucous membranes.

Our conclusions in regard to disorders of the adrenal and parathyroid glands (para. 232 (6)) are given in paragraphs 327 to 332 and the minor ailments mentioned in paragraph 232 (10) are discussed at some length in Chapters 37 to 41.

Part VI

ANALYSIS OF THE CASE AGAINST FLUORIDATION ON MEDICAL GROUNDS

CHAPTER 36: CHRONIC LOW-GRADE POISONING

307. We have listed in paragraph 232 (10) a number of complaints which in themselves are of a minor nature. They included mental and physical inertia, loss of feeling in the fingers, loss of the use of limbs, the dropping of small objects, cramps in the extremities, dry mouth, thirst, nausea, and various skin troubles. It was argued that these minor complaints were the outward expression of chronic fluoride intoxication at a low level of intake. It was said that some persons are more sensitive or allergic to fluoride than others, and on this account some members of the community will exhibit signs and symptoms of low-grade poisoning while others will not. In medical literature a group of signs and symptoms, which are said collectively to represent the effect of a single morbid cause, constitutes a "syndrome". We use this term to cover the signs and symptoms collectively, although it should be emphasised that any one person may not exhibit all these manifestations or all simultaneously.

308. Many witnesses opposed to fluoridation have ascribed the syndrome to chronic fluorine intoxication on the authority of Leo Spira, M.D., PH.D., of New York (formerly of Vienna and London), or of G. L. Waldbott, M.D., of Detroit, Michigan, or of both. In order to give proper consideration to the complaints we have found it necessary to examine in some detail the researches and opinions of these doctors.

309. Dr Spira and Dr Waldbott are the most prominent of a small group of medically qualified persons who have vigorously opposed fluoridation in the United States on many occasions, and each has appeared to give public testimony against the proposals. Dr Spira, for example, gave evidence against fluoridation before the Weir Bill Committee; and Dr Waldbott is reported as having testified against fluoridation at the recent one-day hearing held by the city of New York. Dr Waldbott's wife, Mrs G. L. Waldbott, is the editor of an anti-fluoridation newspaper, *The National Fluoridation News*, published six to ten times a year.

310. Dr Spira has been deeply interested in fluorine poisoning for 30 years. He is the author of numerous articles on the subject published in medical periodicals and of a book entitled, *The Drama of Fluorine: Arch Enemy of Mankind*. We have read most of Dr Spira's publications, including this book, which reveals in detail the origin of his interest in fluorine poisoning and the development of his thought.

311. Dr Waldbott is a well known allergist and former Vice-President of the American College of Allergists and the author of a large number of publications, including a book on this speciality. His interest in fluorine intoxication seems to be recent and to arise mainly out of the intro-

duction of fluoridation in the United States. His publications on the subject of fluorine intoxication are comparatively few in number but we have studied them carefully.

312. To some extent the opinions of the two doctors coincide. However, we think it necessary to examine their theories individually. Reference is made to these matters in the following order:

- (1) Dr Spira's theories in general.
- (2) Examples of the ills which he considers to arise from fluoride.
- (3) Dr Waldbott's opinions in regard to what he calls incipient fluorine poisoning and including some examples of the ailments which are said to be manifestations of that condition.

CHAPTER 37: THE SPIRA SYNDROME

313. In the course of writing his numerous publications on fluorine poisoning Dr Spira has attributed more than thirty ailments to chronic endemic fluorosis, including such things as varicose veins, stammering, left-handedness, nail-biting, defective vision, dysmenorrhoea, and feminism in men (Spira, 1946, 1948, and *The Drama of Fluorine*).

314. Appearing before the Weir Bill Committee in 1954, Dr Spira said:

Fluorine is a nerve poison. It affects the nervous system: its vegetative section which supplies the inner organs of the body and the endocrine glands, as well as its central and peripheral sections – that is to say, the brain, the spinal cord, and the peripheral nerves. The long-continued daily ingestion of at least 1 milligram of fluorine, equivalent to 1 liter of drinking water with a concentration of 1 part per million a day, is sufficient to cause the first evidence of chronic fluorine poisoning.

Organs regulated by the parathyroid glands – four glands embedded one each in the upper and lower pole of both the right and left lobe of the thyroid gland – are most frequently affected. They are the skin and its appendages, the teeth, nails, and hair.

Damage to the skin is manifested by itching, even without visible cause, by outbreaks of boils and weals, by athlete's foot, and, in more pronounced cases, by eczema in any part of the body.

The teeth undergo changes characterised by mottling, which is produced by the ingestion of drinking water with a concentration of at least 1 part per million during the period of calcification of the permanent teeth – that is to say, during the first 8 years of life. Mottled teeth are universally accepted as the first visible external sign of chronic fluorine poisoning. Its other effects are bleeding of the gums, gingivitis, and pyorrhoea.

The nails become so brittle that even a slight accidental knock on a hard object – for example, the edge of a table – causes them to break across. Chalky-white specks, patches, and horizontal lines, closely similar to those observed on mottled teeth, develop on their surface, giving rise to the designation of "mottled nails". The commonest feature is the occurrence of raised longitudinal ridges on the finger and toe nails.

The hair falls out prematurely, leading to a more or less pronounced baldness at an early age.

All these lesions are the result of a disturbed utilisation of calcium, which is stored in the body as a material as indispensable to life and health as is oxygen. The calcium metabolism is regulated by the parathyroid glands. If their normal function is interfered with by the deleterious action of fluorine, the body is deprived of calcium, and only the therapeutic administration of a calcium salt will replenish the deficiency and improve the condition of the victim.

Lesions of the organs regulated by the parathyroid glands (skin, teeth, nails, and hair) are frequently accompanied by brown patches of skin on various parts of the body, closely similar to those encountered in chronic arsenical poisoning. They are evidence of a disturbed function of another set of endocrine glands – the adrenals – which regulate the pigmentation of the body. On treatment

directed against chronic fluorine poisoning, the brown patches of skin disappear. Other evidence of fluorine affecting the adrenal glands are low blood pressure, general lassitude, tiredness, and lack of energy.

The coexistence of large breasts in young men and of female distribution of pubic hair, giving rise to the designation of "feminised males", indicates that yet, other endocrine glands are often affected by the long-continued ingestion of toxic amounts of fluorine.

The fact that all these glands are regulated by the vegetative nervous system indicates that fluorine has a predilection for it at its origin, namely, at the base of the brain.

Moreover, those affected by fluorine in an advanced stage are subject to fits of depression and even melancholia, and to a feeling of apprehension and irritability. It is thus obvious that the substance of the brain itself is involved in these cases.

Neuralgiae in the arms and legs, and attacks of cramps in the calves, occurring mainly at night during sleep, are clear evidence that the peripheral nervous system is likewise affected in chronic fluorine poisoning. There are attacks of "pins and needles", producing the sensation of deadness and numbness in the hands and fingers supplied by the ulnar nerve. It is known that fluorine attacks the ulnar nerve just as lead attacks the radial nerve.

There is severe constipation lasting 2 or 3 days in mild cases and up to 7 days at a stretch in advanced cases of chronic fluorine poisoning. Constipation is associated with excessive gas formation in the bowels and with attacks of colicky pain in the abdomen. Blisters and cracks form on the mucous membrane of the mouth, causing pain on eating and talking.

In this statement Dr Spira has propounded a theory of fluorine intoxication in which the primary harmful action is said to be upon the nervous system. He regards the nervous system as being affected in two ways:

- (1) An effect at the centre with secondary effects by way of nervous connections to certain endocrine organs (parathyroid and adrenal glands). The alleged effects on the endocrine organs are in turn supposed to bring about the signs and symptoms in those parts of the body which the glands are supposed to control. For example, the skin and its appendages (teeth, nails, and hair) are said to be regulated by the parathyroid glands; and
- (2) A direct effect on peripheral nerves, or an effect at the centre with secondary effects on peripheral nerves, causing sensations of "pins and needles" and other manifestations.

315. Dr Spira goes on to mention the particular experience which led him ultimately to conceive this theory of fluorine intoxication:

The symptomatology of chronic fluorine poisoning, as here recounted, is based on an intensive clinical study which I personally carried out in London, England, since 1922 and, more especially, during the recent war on many thousands of recruits, both male and female, serving in the British Army. It was duly recorded in thirty-four papers published in important medical journals in this country, in Great Britain, and on the Continent of Europe.

316. The factual basis of Dr Spira's belief is found substantially in two publications (Spira, 1942, 1944). Dr Spira conducted an examination of 5,019 military personnel, men and women, drawn from all over Britain. He states that 1,099 (20.9 per cent) of these persons were afflicted with mottled tooth enamel. As we have stated in paragraph 110, mottled enamel is not necessarily due to excessive fluoride intake. Nevertheless, Dr Spira appears to have assumed that the mottling exhibited by each one of this group of 1,099 persons was due to fluorine, and he put to them the following questions "with a view to finding if they at any time suffered from some of these symptoms":

1. Do you take salts, pills, or any other aperients? Do you suffer from constipation?

2. Do you ever have "pins and needles" in your fingers? Do they go dead and numb?

3. Have you ever had any boils?

4. Do you at any time have heat spots, heat bumps, or rashes?

5. Do you ever notice loose, shrivelled skin between the toes? Does it peel?

6. Does your hair fall out?

7. Are your fingernails brittle? Do they break easily?

Dr Spira states: "In interrogating those afflicted with mottled enamel teeth, great care was taken to select only such signs and symptoms *as could not possibly be subject* to any mistake or to psychological influences." (The italics are ours.)

317. The following table gives the results of Dr Spira's interrogation and the frequency with which the various signs and symptoms were reported:

Occurrence and Some Signs and Symptoms Co-existent With Mottled Teeth

<i>Number of Cases With Mottled Teeth</i>	<i>Signs and Symptoms</i>	<i>Incidence</i>	<i>Per Cent</i>
1,099	1. Constipation	538	48·95
	2. Paraesthesiae	380	34·59
	3. Furunculosis	324	29·48
	4. Urticaria and other dermatoses	323	29·39
	5. "Dhobi-itch"	205	18·65
	6. Alopecia	317	28·84
	7. Brittle nails	185	16·83
	None	125	11·37

(NOTE—In the table the column headed "Incidence" gives the number of persons who had each particular complaint. The signs and symptoms have been numbered to correspond with the questions.)

318. It seems to us that two vital questions must be answered before the validity of Dr Spira's reasoning can be endorsed. The first question is: "Were all the enamel defects observed by Dr Spira due to fluorosis?" The other, and possibly of even more significance is: "Was there a true correlation between the frequency of the complaints and the occurrence of dental fluorosis?"

319. One answer to the first question posed in the preceding paragraph is provided by a well known English dentist who has conducted much research on the subject of dental fluorosis in Great Britain (Weaver, 1946). He has written:

In 1942 Spira published an article on mottled teeth in Great Britain in which he stated that, out of about 5,000 men and women from many different parts of the country, almost 22 per cent had some degree of mottled enamel. For a country in which a large proportion of the population gets its water supply from moorland sources this is an unexpected figure. Moreover, when, as in this case, Dean's method of grading is adopted, it would be expected in a survey of this kind that cases showing the slightest grade of mottling would be more numerous than those in any one of the more severe grades, but Spira's findings do not conform with this principle. For these reasons it is unlikely that his standard of assessment will be generally accepted.

Another opinion on Dr Spira's diagnosis of the enamel defects is given by Cox (1954):

The basis of his belief that fluorine has caused the conditions which he has reported was his examination of 5,019 adults in England, among whom he found 21·9 per cent showing mottled enamel. However, in the absence of any knowledge of the fluorine content of the water, many of his cases could have had the "white spots" reported in 20 per cent incidence by Houser and Knox in Ohio, where the fluorine of the water did not exceed 0·1 ppm and by Hurme (8) in 142 of 170 persons in New England with fluorine not exceeding 0·25 ppm. The findings of these investigators indicate that the cause of "mottled enamel", in its milder aspects, cannot be interpreted without knowledge of either (a) the fluorine content of the food and water sources during formation of the enamel, or (b) the fluorine content of the enamel.

320. We have already referred to the fact that enamel defects which are not due to fluorosis are common (para. 131 (6)). Taking this fact in conjunction with the compelling argument that the lesser degrees of dental fluorosis cannot be diagnosed with certainty in the absence of knowledge of fluoride intake during the first 8 years of life, except perhaps by the most experienced dental observers, we are satisfied that the number of cases of dental fluorosis amongst the 1,099 persons selected for interrogation by Dr Spira is quite uncertain.

321. In regard to the second question of establishing a correlation between the enamel defects and the occurrence of the fluorine intoxication syndrome, we should have expected a scientific investigator to apply the same interrogation to at least an equal number of persons taken at random from the 3,920 persons who did not have mottled enamel and to report the frequency of the signs and symptoms in this "control group". In the absence of this information we are unable to accept Dr Spira's conclusions that a correlation exists.

322. After careful consideration of all this evidence we are satisfied:

- (1) That Dr Spira did not prove that 21·9 per cent of the service personnel he examined suffered from dental fluorosis;
- (2) That he did not establish a correlation between dental fluorosis and the signs and symptoms of the syndrome under discussion; and
- (3) That the failure to establish these points removes the factual basis which Dr Spira has claimed for his theory and which is described in his own words at paragraph 315 *supra*.

CHAPTER 38: SOME ILLNESSES ATTRIBUTED TO FLUORIDE BY DR SPIRA

323. It has seemed necessary to deal at some length with the basis upon which Dr Spira has propounded his theory. It is not practicable to consider in detail each one of the ailments which Dr Spira has attributed to fluorine poisoning, but some examples are contained in the following paragraphs.

324. *Maculo-anaesthetic Leprosy*—Dr Spira described a case diagnosed as maculo-anaesthetic leprosy in a man aged 25 who had spent the first 17 years of his life uninterruptedly in a village in Cyprus (Spira, 1952a). A sample of drinking water was obtained from the only well used in the village and a sample of the olive oil pressed in the village and used extensively for culinary purposes. The samples of water and oil along

with samples of the patient's hair and nail clippings were submitted to two named analysts who used different methods and reported as follows:

	<i>Nails</i>	<i>Hair</i>	<i>Water</i>	<i>Olive Oil</i>
Analyst A: Fluorine	Not confirmed	0.25 ppm	Less than 0.2 ppm	1.3 ppm
Analyst B: Fluorine	3.7 ppm	1.9 ppm	0.60 ppm	0.16 ppm

325. Commenting on the discrepancies in the analyses, Dr Spira stated:

Until more reliable methods are found, the variable effects of the protracted action of fluorine will have to be gauged chiefly by clinical judgment.

Summarising his observations, Dr Spira stated:

A case of maculo-anaesthetic leprosy is recorded which was accompanied by the presence of "mottled teeth". Since mottling of the teeth is one of the external manifestations of chronic fluorine poisoning, and also because several of its signs and symptoms are closely similar to those of leprosy, *it is suggested that the two conditions may be identical.* (The italics are ours.)

326. It will be understood that Dr Spira is here *suggesting* a relation between a serious disorder and fluoride poisoning. But he is doing so without any evidence that the mottling of the teeth was dental fluorosis or that the fluoride intake of the patient was excessive at any time. It seems to us that this type of speculation has no scientific basis whatever.

327. *Parathyroid glands*—Dr Eva Hill (*Hastings Address*, page 6) and several other opponents of fluoridation stated that fluoride has a harmful effect on the parathyroid glands. These statements appear to be based on the views of Dr Spira, who wrote as follows (Spira, 1952a):

Fluorine is a nerve toxin, whose deleterious action consists in its *ability to precipitate calcium salts stored in the body* as a material indispensable for sustaining the vitality of most of the organic functions. This results in a diminished calcium content of the body, and in increased irritability of the peripheral and vegetative nervous systems. It is not yet definitely established whether this effect is brought about in a direct manner or through interference with the calcium-regulating function of the parathyroid glands. *The latter assumption* (Spira, 1942) was based on the fact that organs biologically originating in the ectoderm and regulated by the parathyroid glands, namely the skin and its appendages, the teeth, nails, and hair, are affected in chronic fluorine poisoning. (The italics are ours.)

328. The statement "ability to precipitate calcium salts stored in the body" seems to us to be unsupported by any evidence. Proceeding, however, from this unsubstantiated speculation, Dr Spira makes an assumption, as he himself acknowledges, that the interference with the functions of the nervous system may be direct or through the calcium regulating function of the parathyroid glands. In the later Weir Bill statement (para. 314) it will be observed that still another mechanism is mentioned. Indeed, we find it difficult to discover exactly where Dr Spira puts impaired parathyroid function into his scheme of causation except in so far as he claims that these glands affect skin, hair, and nails. If he had suggested the thyroid gland, we would have found it easier to understand his reasoning. We have already described, however, the evidence which proves that the thyroid gland is not affected by small amounts of fluoride (Chapter 31).

329. A careful study of the effects of toxic amounts of sodium fluoride (0.15 per cent of the diet) on the parathyroid glands was made by Hauck, Steenbock, & Parsons (1933). They summarised their conclusions as follows:

We found no evidence that the parathyroid glands in the rat undergo any consistent significant change, either grossly or microscopically with the administration of toxic doses of sodium fluoride. Therefore, the explanation for the apparently identical dental effects produced by sodium fluoride administration and parathyroidectomy must be sought in some other mechanism unless in this respect anatomical criteria are of no value.

We have explained that we are unable to understand the reasoning which persuades Dr Spira that fluoride has an adverse effect on the parathyroid glands. A contrary view is expressed in the foregoing statement and, in view of the careful study upon which the opinion is based, we are satisfied that the relatively minute amount of fluoride involved in the fluoridation proposal does not have any harmful effect on the parathyroid glands.

330. Before leaving this topic we refer to a subsequent paper by Dr Spira (1944) in which he states how he examined a randomly chosen group of 850 men (average age 29) and 850 women (average age 21) drawn from various parts of Britain. He studied the incidence of mottled teeth in this group and describes "the astonishing fact that as many as 48 per cent of the 1,700 people examined exhibited some degree of mottling of their teeth". Once again he regarded this as a sign of exposure to excess of fluorine whatever the appearance and degree of the enamel defect. He then reported the frequency of imperfections in the nails, baldness, athlete's foot, and hammer toes, and came to the conclusion, which does not surprise us, that these disorders are not at all uncommon in such a group of the population. He did not report any information about the fluoride intake of any of these 1,700 people and, despite this, has summarised his conclusions as follows:

Dystrophies due to chronic fluorine poisoning in organs regulated by the parathyroid glands, namely, the skin and its appendages, the nails, teeth, and hair, and also the bones, are here shown to be unusually common in this country. (Great Britain.)

We have observed here and in many other of Dr Spira's writings that he uses what is, in our view, a fallacious argument in a circle. Having *assumed* that a given clinical sign is due to fluorine poisoning, he then uses the existence of the same clinical sign to *prove* that the patient is suffering from fluorine poisoning; and when his views are stated dogmatically, as they were, for example, before the Weir Bill Committee, his speculative assumptions and hypotheses are stated by him as if they were facts. In these circumstances it is not surprising to us that lay readers, unacquainted with the process of reasoning, should be misled and become concerned.

331. *Adrenal Glands*—Dr Eva Hill (*Hastings Address*, page 5) stated:

Fluoride has a very definite and specific action on the *adrenal glands*. Chronic fluoride poisoning, by this action, has a tendency to cause patches of discoloration in the skin.

It seems that she is referring again to Spira (1946, 1949a, 1950a) who described two cases diagnosed as Riehl's melanosis in which there is irregular pigmentation of the skin, especially where it is exposed to light.

332. Dr Spira (1950a) writes:

To throw further light on the *hypothesis* that Riehl's melanosis *may be due* to chronic adrenal insufficiency caused by a disturbance of the vegetative nervous system in the course of chronic fluorine poisoning (in which other endocrine glands, especially the parathyroids, may be simultaneously affected) a series of laboratory tests were carried out. (The italics are ours.)

The patient's domestic water supply contained 0.15 ppm of fluoride. The patient's hair contained 2 ppm of fluorine and nail parings 30 ppm. Dr Spira says:

As far as I know, there is no reliable information on the fluorine content of nails and hair.

The low blood pressure, low blood sugar, high blood urea, and other laboratory findings were taken as indicative of chronic adrenal insufficiency. Whatever the cause of the pigmentation may have been, it is quite clear to us that Dr Spira possessed no data which related the patient's condition to his fluoride intake. There appears to be no other basis for the suggestion that fluoride at concentrations relevant to this inquiry might be harmful to the adrenal glands. We are satisfied that in fact the suggestion is unfounded.

CHAPTER 39: CONCLUSIONS IN REGARD TO THE SPIRA SYNDROME

333. In several publications Dr Spira indicates that his experimental work on fluorine intoxication in rats (carried out in the Department of Physiology, Middlesex Hospital Medical School, London) has played some part in the development of his views. We have read the papers on experimental fluorine poisoning in rats (Spira, 1949b, 1950b, 1952b) and we have heard comment on them in the evidence of Dr Muriel Bell at Hastings. Dr Bell criticised the diets used in the first series of experiments (Spira, 1949b) as inadequate and offered the opinion that the rats were suffering from multiple nutritional deficiencies and that they were affected with rat scabies. She pointed out that the gross effects described did not occur until the fluoride concentration of the drinking water was stepped up to 160 ppm and more. In the later experiments (Spira, 1950b) when the diet of the rats was made adequate by supplementing with a group of B vitamins there was a very different picture, and the concentration of fluoride was raised to much higher levels (400 ppm) before it produced relatively mild toxic effects. Dr Bell said:

It is pretty obvious that he (Dr Spira) reasons from giving toxic amounts of fluorine to rats that fluorine in the very small concentration of 1 ppm is toxic to human beings.

334. It appears to us that the techniques used and the reasoning employed are open to criticism on scientific grounds and we are of the opinion that the experiments are not relevant to what may happen when animals consume water containing 1 ppm of fluoride.

335. In coming to a conclusion on Dr Spira's extensive writings on the question of fluorine, we consider that he has consistently failed to demonstrate that the signs and symptoms which he has ascribed to chronic fluoride poisoning at a low level of intake are in fact due to fluoride and not to some other cause. We have given Dr Spira's theories the most careful consideration. We are satisfied that they have no valid foundation.

CHAPTER 40: THE WALDBOTT SYNDROME

336. As we have stated, Dr Waldbott also believes in the existence of a syndrome comprised of minor ailments which he regards as the manifestations of incipient fluorine poisoning. He states:

No information on the incipient stage of this disease which would make it possible to establish an early diagnosis can be found in the literature. (Waldbott, 1956.)

He states also that a case which he described presented:

presumptive evidence of incipient chronic fluorine poisoning from drinking water at 1 part per million. (Waldbott, 1955b.)

In addition to clinical observations, Dr Waldbott, like Dr Spira, has used a questionnaire to gather data (see para. 359).

337. In reviewing his observations Dr Waldbott states:

One is impressed by the sparsity of objective findings, by the absence of changes in joints, bones, and teeth, and by the great variety of symptoms. Nevertheless, on carefully examining the case reports, a clear-cut disease pattern can be discerned. . . . The most characteristic manifestations are backache, numbness, and pain in the legs and arms, especially in the ulnar area, gastro-intestinal and bladder disturbances as well as ulcers in the mouth and visual disturbances. Most impressive are extreme malaise and mental sluggishness. Two unusual phenomena may perhaps be considered pathognomonic as they probably occur in no other disease: the more water the patient drinks the more he complains of dryness in the mouth and throat (this is in distinction to acute poisoning in which excessive salivation is a major symptom). Exhaustion is most pronounced when the patient should feel most rested, namely, in the morning after resting at night. Arthritis, headaches, and seborrhoeic dermatitis may or may not be a feature of this disease.

Elsewhere he mentions brittle and breakable nails, gastritis, and irritation of mucous membranes in the alimentary and lower urinary tract.

338. It will be seen that Dr Waldbott's description of the syndrome is almost identical with that of Dr Spira, but he appears to be more cautious. "So far," he has said, "the evidence that this is fluorine poisoning is presumptive," and he states the facts on which the presumptive conclusion is based. He discusses the possibility of a psychosomatic basis (the influence of the mind and emotions on bodily health) for the syndrome and dismisses the possibility but on grounds which appear to us to be quite insufficient. Finally, Dr Waldbott says:

The evidence presented so far is lacking final substantiation by determination of fluorine in urine, blood, and in bones and other organs. Such studies are now in progress.

339. Basing his data on fifty-two cases, Dr Waldbott (1956) summarises the signs and symptoms described in paragraph 337 and goes on to state:

The evidence so far is based on: The identity of the symptoms observed with those described: (a) in my first reported case from artificially fluoridated water; (b) in industrial poisoning in men; (c) in fluorosis encountered in natural fluoride areas; (d) in animals grazing near plants emanating fluorides. Whereas there is an appreciable deterioration of general health, laboratory and objective findings are sparse at this stage of the disease. The cardinal features associated with advanced fluorosis, namely, changes in bones, ligaments, joints, and teeth, were not noted in its incipient stage.

Further corroborating studies now in progress, indicate that a variety of diseases of heretofore unknown origin, may be due to, or at least aggravated by, traces of fluorine in air, food, and water.

340. The evidence for the syndrome as outlined by Dr Waldbott consists of:

- (1) Identity of the symptoms with those described in the first case (Waldbott, 1955b); and
- (2) Analogies with industrial poisoning, fluorosis due to excessive ingestion of high-fluoride water, and fluorosis in animals grazing near industrial plant from which the hazard emanates.

We have been informed by Mr Penlington by letter dated 17 June 1957 that Dr Waldbott is to publish a series of five articles, the first of which has already appeared (Waldbott, 1956). The first of this series is referred to in paragraph 339 and shows that Dr Waldbott has not changed the basis for his theories. This basis we now proceed to examine.

341. There is no evidence that the symptoms exhibited by Dr Waldbott's first case were in fact due either to the 1ppm of fluoride present in the water consumed or to any other fluoride ingested, and there is no rational basis for concluding that the existence of analogies is proof that the syndrome is due to fluoride. Dr Waldbott has introduced a doubtful note at the conclusion of his summary where he states that "a variety of diseases of heretofore unknown origin, *may be due to, or at least aggravated by*, traces of fluoride in air, food, and water". (The italics are ours.) These statements suggest that he is aware of the fact that he possesses no scientific evidence to demonstrate that the syndrome is caused by fluoride.

342. In the absence of evidence to demonstrate that the conditions described are due to fluorine poisoning, both Dr Waldbott and Dr Spira have used "therapeutic tests" to support their arguments. In these tests fluoridated water has been withdrawn and low-fluorine diets have been prescribed. Both physicians have claimed disappearance of symptoms after these and other precautions were taken. In no case has the actual fluorine intake been measured, and only in one case was the urinary fluoride excretion determined in relation to the test. These arguments are unconvincing and fail to persuade us that the effects described were due to the withdrawal of fluoride, real or presumptive.

343. Both Dr Spira and Dr Waldbott have suggested that the intake of small amounts of fluorine leads to the loss of calcium from the body. Lay witnesses have put this more graphically by saying that fluoride is a "calcium robber". Dr Waldbott has published a urinary analysis which, he states:

suggests a close relationship of calcium excretion with fluorine output in urine.

It is very difficult to determine the calcium balance of the human body. Despite this, Dr Waldbott, (1956) appears to attach special significance to the figures for calcium excretion in three 24-hour samples of urine taken on separate days, 16 April, 23 April, and 15 June 1956, without reference to calcium intake. The excretion dropped from 0.705 grammes, which is an unusually high value for urine, to 0.300 grammes between the first and the last days; simultaneously the fluoride excretion fell from 4.7 to 0.69 milligrams. Normal values for calcium excretion in urine are said by Dr Waldbott to be 0.3 to 0.5 grammes. The well water originally consumed by the subject contained only 0.8ppm of fluoride, but he changed to fluoride-free water on 23 April. If these figures represent a substantial drainage of calcium from the body stores, as Dr Waldbott implied, continued ingestion of fluoride should lead to

rarefaction of bones. No such condition has been observed in persons residing for 10 years or more in places where the water contains 1ppm of fluoride or more (paras. 240, 241, 252, 253).

344. The chief sources of calcium in the diet are milk, cheese, and vegetables. Drinking water provides comparatively little and, in most parts of New Zealand, a negligible amount. The average daily intake of available calcium in New Zealand approaches recommended standards. We have calculated that if the available fluoride intake were as high as 5 milligrams per day as a result of consuming fluoridated water, tea, and fluorine-containing foods, and if this fluoride did in fact remove its equivalent of calcium from the food (but there is no evidence that it does this), the amount removed would be less than 3 per cent of the available calcium intake. At the known absolute level of intake this would be quite negligible. We are of the opinion that discussion of calcium balance in terms of calcium salts instead of in terms of calcium ions has led to erroneous thinking, and we are satisfied that the consumption of water containing 1 ppm of fluoride could not deprive the body of any significant amount of calcium.

CHAPTER 41: CONCLUSIONS IN REGARD TO THE SPIRA-WALDBOTT SYNDROME

345. At this point we summarise our conclusions on the "Spira-Waldbott Syndrome" as follows:

- (1) We are of the opinion that the individual signs and symptoms of the alleged syndrome may be due to any number of unrecognised causes; and
- (2) We are satisfied that there is no causal relationship between any of these signs and symptoms and the ingestion of water containing 1 ppm of fluoride and food cooked in this water.

CHAPTER 42: THE PROFESSIONAL WITNESSES OPPOSED TO FLUORIDATION

346. We have listed in the foregoing chapters the various general or specific complaints that fluoride is harmful to health and we have described the evidence made available to us by those medical witnesses who deny that the substance is harmful. We have also considered in some detail the basis upon which the Spira-Waldbott syndrome has been put forward. The views of Dr Spira and Dr Waldbott appear to us to provide the foundation for most of the complaints put forward on medical grounds. We have heard evidence, however, from several medical practitioners in this country and we have been referred to certain opinions expressed overseas. In addition, various lay witnesses have described fluoride as dangerous to health. We turn now to a general consideration of these various opinions.

347. The evidence falls into four categories:

- (1) Four New Zealand medical practitioners who appeared to give evidence provided us with their opinions.
- (2) There are the opinions of certain individuals living overseas whose views were made available to us through various publications.

- (3) There were certain witnesses who claim to have been affected adversely by the fluoridated water at Hastings.
- (4) Reference was made by Mr Penlington to twenty-three letters which he had collected in 1954 written by persons in the Hastings district complaining of such effects.

We consider the evidence in the order listed.

348. Dr Elizabeth Mudie is one of the four New Zealand doctors who opposed fluoridation. She practises as a general practitioner in Dunedin. The specific attack on medical grounds which she made against fluoridation was limited to a statement that fluorosis developed in workers exposed "to an appreciable intake of fluorine" followed by an account of the results of that condition. Her evidence on this matter reads (7R 1):

Fluorosis of the skeleton results in increased density of the bone with formation of the osteo-phytes, calcification of ligaments, tendons, and interosseous fascia. All bones may be affected, but the most severe changes are in the vertebral column giving rise to pain, stiffness, and limitation of spinal movement. Radiographs show diffuse osteosclerosis, with the formation of new bone from periosteum and calcified ligaments – changes which have been described and illustrated in the *British Medical Journal* of 10 December 1955. Other symptoms of fluorosis are anaemia and abnormalities of the central nervous system, decrease in the medullary cavity diameter, and pressure on nerves from bony ingrowth in the spinal canal.

Among the group of workmen crushing cryolite (sodium aluminium fluoride) used in the aluminium industry it was revealed that silicosis was present in the X-ray picture of the lungs in a number of cases, but the most striking finding was that in 30 out of 78 subjects who were examined, increased density of bone and absence of sharp contours, due to osteosclerosis, formation of new bone, and calcification of ligaments were demonstrated. Fluorosis has also been found to culminate in insanity.

Mr Woodhouse: Before going on, I wonder (since you are on this point) if you have got the daily intake of fluoride of those cryolite workers? . . . I am practising an art – not a science! I leave that to the people who spend all day looking through microscopes.

I was wondering if you had that figure available. . . . I am not interested in that figure and I am not going to be sidetracked.

349. Quite obviously the reference to the cryolite workers concerns certain researches of Roholm and the same researches were discussed before us by Dr Bell. She explained that the workmen had absorbed large quantities of fluoride daily for over 10 years and then she said (7P 1):

The evidence Roholm gives that no harm came to the kidneys or heart or blood vessels, even when the cryolite workers inhaled so much dust as to put 70 milligrams of fluoride ion into their lungs daily, a quarter of which he estimated that they absorbed, is so convincing that there is no shadow of doubt about the harmlessness of fluoridation at the proper level.

350. Dr Bell described the quantities of fluoride inhaled daily; the period over which it was ingested; and provided us with some conclusion based upon the results that has some relation to the fluoridation proposals. Unfortunately, Dr Mudie does none of these things. In regard to her bare assertion that fluorosis culminates in insanity, she produced no evidence of any sort which might aid us in arriving at a proper conclusion. We have been unable to derive assistance from her evidence on the medical questions which require to be answered.

351. Dr Maud Fere practises medicine as a general practitioner in the Christchurch district. The evidence she gave on the medical question related to fluoride is contained in the following brief statement (9A 2):

Sodium fluoride can, and does, cause calcification of the joints in adults, and mottling and deformities of the teeth in children . . . it takes anything from 10 to 20 years to produce the effect in old people. . . . In Newburgh, New York, it is stated to cause dry births, dead babies. It used to be classed as an abortion drug. The bad effects of sodium fluoride are progressive and there is no known cure. It causes damage to the brain, liver, kidneys, and thyroid glands. . . . Sodium fluoride is one hundred times – I should say more than one hundred times – more poisonous than calcium fluoride. . . . Cancer will certainly be much increased by fluoridation.

A little earlier she had referred to fluorine in terms which appear to be identical with those contained at page 6 of the booklet *Fluoridation the Poisoner* by Madam Mira Louise. The description used by Dr Fere is as follows:

The British Chemical Advisory Board stated that fluorine is the identifying element in the fatal nerve or “madness” gases developed for use in chemical warfare. It is so deadly that one breath of the vapour will cause death in a few minutes; a drop on the skin will kill within 30 minutes; and no clothing, not even rubber, can keep it out.

She went on to say:

A traitor in wartime could poison a whole population by manipulating the drinking water. It is colourless, odourless, and tasteless. Sodium fluoride can and does reduce the mentality and willpower; and some think it was used by Hitler.

352. We have stated in paragraphs 201 and 206 that descriptions of this sort applied to the subject of fluoridation are entirely misleading. When asked about her use of these exaggerated expressions Dr Fere readily stated that she felt it was necessary to frighten people about the matter. We disagree.

353. Concerning the medical questions which she put before us, Dr Fere was candid enough to admit that she had not investigated the allegations she made and she said that she had interested herself in the subject of fluoridation only very recently. She went to state that as “the people are terribly overcharged as it is with sodium” (9B 1) her concern was directed more to the sodium component of the compound sodium fluoride proposed to be used than to the fluoride component. We regard these facts as detracting from the value which otherwise might attach to the evidence she gave as a qualified medical practitioner.

354. Dr Ulric Williams also appeared before us to object to fluoridation. He practises medicine in Wanganui. Substantially, his evidence (9L 2–9M 1) was directed to a general consideration of a natural diet in preventing sickness or disease and he argued from that premise that fluoridation was “a lying would-be alternative to spiritually intelligent living” (9L 2). In stating that he first interested himself in the subject of fluorine at the time the water supply in Hastings was fluoridated, he said that his principal authority on the subject was Charles Eliot Perkins (see para. 364). He described fluoride as a calcium thief and as a cumulative poison which gave rise to “a variety of serious disorders”, but he did not specify these disorders or give any other evidence concerning the medical implications of fluoridation.

335. Dr Eva Hill is the fourth of the New Zealand medical practitioners to appear before us in opposition to fluoridation. She gave evidence at Auckland and again in Wellington. She is a general practitioner practising in the North Auckland district and stated that she became interested in this subject 2 or 3 years ago. She provided us with her opinions in some detail and, as we have mentioned, founded those opinions upon the writings of Dr Spira and Dr Waldbott and also of

several other persons residing overseas. All these persons were also relied upon by various lay witnesses to justify complaints by them that fluoride is harmful to health. To the extent that we have not done so earlier in this report, it is necessary to include an evaluation of the opinions of these overseas authorities who have been relied upon by Dr Hill and other witnesses for their own attitude to fluoridation on medical grounds.

356. Dr Hill informed us that she first studied the question of fluoridation by reference to the report of the congressional inquiries in the United States of America held in 1952 and 1954 (Delaney Report and Weir Bill Report). In the course of her evidence, although she mentioned with approval the published works of certain overseas writers who oppose fluoridation, she did not assist us by any critical analysis of the scientific papers which were relied upon by the doctors supporting the proposals. In regard to her approach to the subject Mr Woodhouse invited her to agree that a conclusion should be reached on scientific principles. Dr Hill, however, did not agree as the following extract taken from the record of her evidence indicated (6E 2):

Now this sort of thing needs to be decided on a scientific basis. I am now talking about the medical aspect of it? . . . I do not think so. I think it needs only applied common sense and intellectual honesty. It is not a scientific question.

Later she was asked why she had used the expression "rat poison" in relation to the fluoridation proposals, and this extract reads (6H 2):

I do suggest to you that it would be a great pity to unnecessarily frighten people about this subject. This is a serious matter? . . . It is a serious thing, and the more they are frightened the more they will investigate it, and the truth will make them free.

You think they should be frightened a bit? . . . They certainly should and many of them are.

357. Earlier Dr Hill had been asked to explain why sodium fluoride was 85 per cent more toxic than calcium fluoride as she had claimed, and her explanation was that the second substance was not stored in the body whereas sodium fluoride was, and then appears this extract taken from page 6G 4:

Do you not accept the proposition which has been put before the Commission that when these substances dissolve in water the fluorine ion separates from the compound? It is not, as I understand it, the compound that is in solution but the fluorine ion is separated off. Do you not accept that? . . . I cannot go into all those points because I am not versed enough.

Do you or do you not accept the suggestion? . . . I do not understand it fully enough to accept or refute it.

This appears to indicate that Dr Hill's opinions are based on a belief that the *compound* sodium fluoride is stored in the body and are not directed to the toxic properties of the fluoride component. If this be her view, we have had no evidence from any other quarter which would support it. We propose, however, to consider the evidence she gave on the basis that the dangers to health which she has mentioned are in relation to the effects of fluoride.

358. One group of overseas authorities relied upon by her for many of her own views consists of Dr Spira, Dr Waldbott, Dr Royal Lee, Mr Charles Eliot Perkins, Professor Steyn, and Dr Exner. These gentlemen were mentioned on many occasions during the course of this inquiry, and with the exception of Professor Steyn, who is resident in South Africa, they all appear to have taken a prominent part in anti-fluoridation campaigns in the United States of America.

359. In Chapters 36 to 41 we have already considered in detail the principles upon which Dr Waldbott and Dr Spira have permitted themselves to diagnose cases of incipient fluorine poisoning. A German doctor named Hörnung interested himself in this matter and has written that Dr Waldbott's method of diagnosis involved the use of a questionnaire. This contained what he regarded as leading questions. According to Dr Hörnung, he was told by Dr Waldbott that whenever a question was answered positively, Dr Waldbott regarded the answer as proof of poisoning by fluoridation. Symptoms described included the following:

Numb in half my hands.

My memory got bad.

I do not feel refreshed in the morning as I used to.

I cannot hold the song book in church.

My nails split, peel off, break, and become rigid.

Dr Hörnung was not unnaturally sceptical as to the value of these answers and accordingly he sent a questionnaire to residents of his home town in Germany which had a chlorinated water supply but no fluoridation. He writes that he received in answer to his questionnaire numerous affirmative answers which, on the basis of reasoning used by Dr Waldbott, would have enabled him to diagnose chlorine poisoning (*Journal of the American Dental Association*, September 1956). Dr Waldbott issued a statement in regard to the foregoing matter which was printed in the *Pontiac Press* on 8 November 1956. In that statement he said: "For preliminary orientation in some of my cases, a questionnaire method was used, a perfectly valid scientific approach. However, careful laboratory and clinical data form the basis of my reports." We refer to data of this type in paragraph 343.

360. We have already referred to the sample questions put to patients by Dr Spira (see para. 316). These questions like Dr Waldbott's are leading questions and refer to various minor ailments. Rather similar symptoms were outlined in an advertisement which appeared in the *Hawke's Bay Herald-Tribune* in October 1955. In regard to this advertisement, Mr Woodhouse directed a number of questions to Dr Hill as appears in the following extract (6F 2):

Dr Hill, I have had handed to me a copy of what is allèged to be an advertisement in the *Hawke's Bay Herald-Tribune* on Thursday, 27 October 1955, indicating that you would speak in Hastings. . . . Yes.

In the body of it is this statement - Dr Hill wishes to receive reports of any ill effects experienced after drinking fluoridated water. Symptoms complained of in the United States of America are irritation of eyes, mouth, throat, and stomach, followed by backache, numbness in legs, partial paralysis of hands, brittle nails, skin irritation" - and then an invitation to anybody who might be suffering from any of those complaints to communicate with you. . . . Yes.

The question I put to you is, would you not think it a bit leading to invite people to consider whether they have got those particular complaints? . . . Yes. I did not insert the advertisements. I knew nothing about it.

I do want you to understand that I am not assuming you took the responsibility for this; but that is rather an unwise type of question? . . . Of course it is.

361. The fact that Dr Hörnung and Dr Hill both express some scepticism in regard to the "questionnaire" method of diagnosis is not conclusive on the point but in the case of Dr Hill her own criticism is relevant in so far as she relies upon Dr Waldbott and Dr Spira as authorities on the subject of fluorine poisoning. Dr Bell characterised this method of diagnosis as having no relation between cause and effect and as being unscientific (2S 1). We note, however, that, according to Dr Hörnung, Dr Waldbott himself applied the same description to the work of Dr Spira.

362. An unpublished paper (Adcock, Berry, & Forrest, 1957) was submitted by Dr Bell describing the results obtained after putting to groups of children questions modelled on Dr Spira's questionnaire. The answers produced an entirely random result and no conclusion could be drawn from the experiment.

363. Dr Royal Lee was stated by Dr Hill to be the proprietor of two large businesses in the United States of America which marketed "natural vitamin preparations" and to be an authority in the field of nutrition. The only evidence as to his qualifications indicates that he graduated as a dentist but never practised. He appears to include the publishing of books in his business activities as his Foundation for Nutritional Research is the publisher of Dr Spira's book *The Drama of Fluorine: Arch Enemy of Mankind*. We were not referred to any other material which would enable us to regard Dr Royal Lee as providing any effective support for the view that fluoridation is harmful to health.

364. Mr Charles Eliot Perkins was described by Dr Hill (6G 2) as having "the most interesting and informative and best approach to the cancer problem" of anybody she had met, but she went on to say: "I cannot tell you what his academic training was". Dr Hill stated that he had expressed the view that fluoride increased the incidence of cancer. So far as we can learn, Mr Perkins does not appear to have made any contribution to any of the reputable Cancer Journals and we were told he was not listed in "American Men of Science". We were not referred to any qualifications he might possess in the field of fluoride research by Dr Hill or by Dr Ulric Williams, who also cited him as an authority on the subject. In the course of her evidence Dr Hill stated (*Hastings Address*, page 5):

Fluorine acts as a catalyst in accelerating certain pathological processes. Charles Eliot Perkins, internationally known for his original discoveries in the field of cancer research, and now considered one of the greatest contributors towards solving the cancer problem says: "Chronic fluorine poisoning, by ingestion in food or water can become a potent factor in accelerating cancer progress. Kidneys, heart, nerve and brain tissues are violently attacked. Mental degeneration is rapid."

Like Mr Perkins, Dr Hill failed to enlighten us as to the basis for these claims.

365. Mr Perkins gave evidence for the plaintiffs in the American case of *Genkinger and Others v. City of Newcastle Water Company*. We do not think it necessary to regard the view of the Court in that case as decisive in our own attempt to put a proper value on Mr Perkin's work in connection with fluoride. It does have some relevance, however, as the subject matter of the case was the question of fluoridation. The judgment of Judge Braham was given on 4 March 1955 and includes the following statement:

Charles Eliot Perkins, witness for the plaintiffs, was not convincing as an expert. The Court may take judicial notice of the enormous advantage which has accrued to the public health from the work of devoted scientific men in laboratories, clinics, and schools. In the great majority of cases this has been done by men thoroughly prepared, aware of the progress of their science, and thinking of themselves as only workers with others in the ranks of that science. Mr Perkins, on the contrary, with comparatively meagre preparation, flouts ordinary procedures and recognised scientific men. His knowledge of the subject here in dispute is, like his cure for cancer, impulsive, erratic, and unsound.

366. We have been unable to discover any evidence which would indicate that Mr Perkins bases his opinions on orthodox principles of science or medicine and in the field of fluoridation we are not persuaded by his views.

367. Dr Exner's opinions were mentioned on various occasions by Dr Hill and several other witnesses including Mr Cape Williamson. In Christchurch it was pointed out to Mr Cape Williamson (8P 1) that Dr Exner had made favourable reference in his publication *Fluoridation of Public Water Supplies* (1955) to a portion of a decision in one of the Courts in the United States of America but without explaining that the portion cited was from the minority opinion of the Court. The following extract then appears in the notes of evidence:

Dr Exner does not refer to the fact that the majority of the Judges took the different view, does he? . . . No, he does not.

Don't you think it would have been wise for him to have done so? . . . Certainly, but I suppose he was like all advocates—

But the point I am putting to you is this— . . . I see your point and I agree with you. To be absolutely impartial he should have mentioned it.

The matter may be of little significance in itself, but we consider it an example of the fact that Dr Exner's publication frequently reflects his views as an advocate. This attitude might not be understood by many persons reading a work which they probably would expect to contain the dispassionate findings of a scientific observer.

368. We have referred in some detail to Dr Exner's publication *Fluoridation of Public Water Supplies* in paragraphs 90 to 97. We think Dr Exner's rather confident assertions in relation to fluoridation are frequently based on a misconception of the facts to which he makes reference, and in paragraph 97 we have expressed our conclusion that his report is lacking in objectivity.

369. Professor Steyn was mentioned by several witnesses including Dr Hill, who stated (*Hastings Address*, page 2):

Professor Steyn, Professor of Pharmacology at Pretoria University, who has studied the effects of fluorine on the thyroid gland in connection with its goitre-producing propensities, says: "All the evidence at our disposal indicates that fluorine is a toxic substance and plays no 'biological role' (that is, it is not essential for life)."

Dr Hill produced a copy of a letter which Professor Steyn published in the *Rand Daily Mail* on 8 October 1954 indicating in part that there could be great improvement in the problem of tooth decay if the teeth were properly brushed, correct food was eaten, and by "thoroughly rinsing the mouth with a 0.5 per cent solution of sodium fluoride every evening after having brushed the teeth". On 13 January 1955 Professor Steyn corrected the figure of 0.5 per cent to 0.05 per cent. This corrected figure is, of course, a concentration of 500 ppm which Professor Steyn recommends as a mouth wash, no doubt because of the beneficial topical effect of the fluoride on the surface of the enamel of the teeth. In relation to this fact Dr Hill answered a number of questions put to her in the following way (6E 4):

That does suggest that he thinks that fluorides do have some beneficial effect, whatever the concentration may be? . . . A lot of people think so.

Yes, and he thinks so? . . . He does, yes.

Do you consider that he is sadly in error in that respect? . . . Everybody makes a mistake occasionally, but that is wrong as a whole — it doesn't really make sense.

Whether or not Professor Steyn is mistaken in his views on this matter he appears to believe that fluoride performs some valuable role in the formation of the teeth, and in this event Dr Hill's statement that he considered it "plays no biological role" is difficult to understand.

370. We have referred in paragraph 289 to the opinions which Professor Steyn has expressed in regard to the effect of fluoride on the thyroid gland. In this regard it appears to us that the incidence of goitre in the areas concerned is unrelated to the fluoride content of the water. We accept the opinion expressed by Dr Purves, together with the reasons he gave for that opinion, that at levels of 1 or even 5 to 10 ppm fluoride has no detrimental effect on the thyroid gland.

371. In the course of her evidence Dr Hill referred with approval and invited us to consider the opinions of Dr H. V. Smith and his wife Dr M. C. Smith, who for many years in the southern area of the United States have carried out valuable researches in many directions including the effects of fluoride upon the human body. Certain views which they had expressed in 1931 and 1935 were referred to us by Dr Hill as indicating their belief that as little as 1 ppm of fluoride in drinking water would cause mottled enamel. She was asked to consider the fact that on 28 September Dr H. V. Smith had written a letter to Dr Davies which stated in part "if the mean temperature is 59°, as in Dunedin, I do not believe that mottled enamel will develop from water of 1 ppm fluoride." The following extract from the evidence explains Dr Hill's views on that fact (6E 3):

That would surely affect what you say about that matter on page two? . . . Dr Smith is not the only one who has investigated this — many others have.

The point I am making is that you are quoting Dr Smith. . . . That is what she said previously.

Yes, previously. . . . Yes.

But it appears that Dr Smith has changed her mind? . . . It is only quibbling about it; it is a minor detail which doesn't affect the whole issue.

The present opinion of Dr Smith and his wife on these matters appears to us to be no more quibble but a matter of some importance.

372. In paragraph 89 we have referred to the confusion which had arisen in the minds of some witnesses by reason of a report of Dr J. A. Forst of the New York State Department of Education which appeared to show that children in Newburgh (with a fluoridated water supply) had more dental defects than the children of Kingston (with a low-fluoride concentration in the water). Dr Hill stated that this was the position; but in cross-examination she admitted that she was aware of the explanations which had been made in regard to the matter. She was then asked (6E 2):

You would remember what Dr Ast says? — that the school authorities in Kingston used a school physician to do the dental inspection and he carried that out with a tongue blade. In Newburgh, however, the school authorities employed a school dental hygienist, who does a careful tooth-by-tooth inspection? Dr Forst, on 17 December 1954, seems to have written a letter saying, "A child with ten or even more individual teeth involved with dental caries is reported as a child with a dental defect?" Doesn't that have a very material bearing on what you refer to here in paragraph one? . . . Well, I don't know that it does, really. It shows if different examiners do make these tests that none of them can be conclusive.

I hope you have understood what I am trying to put to you——. . . I see what you mean.

The situation is that in the one case there was a careful clinical examination and the number of individual teeth with holes were totted up, and in the other, if a child had one or ten holes that was simply recorded as "one case". You cannot compare that, can you? . . . Well, it is the number of children.

Yes, but surely to compare them there must be the number of children in both cases? . . . I think that is just really a matter of quibbling and as the conditions in the two towns were not the same to start with, no reliance can be placed on any of these examinations in either direction.

If Dr Hill believed that no reliance could be placed on either of the examinations, as she suggests in the foregoing extract taken from her evidence, then we do not understand why she referred us to the results at all. Apart from this, however, the fact that the two sets of figures are counts of unlike things completely invalidates any argument that attempts to show that fluoridation has been ineffective. We do not consider this distinction to be, in any sense, "just a matter of quibbling".

373. In the course of her evidence Dr Hill expressed her opinion that fluoride could be the cause of a formidable number of illnesses. We have dealt with the individual items in various parts of this report and in each case we have decided that fluoridated water cannot cause the particular trouble envisaged by Dr Hill. In arriving at her own opinion Dr Hill appears to us to have been handicapped by the fact that she has relied on the utterances of some of the persons referred to earlier in this chapter whose views are unsupported on any scientific basis.

In addition, many of her opinions are merely suggestions. In this regard the following extract from her evidence (6G 3) has some relevance:

Now, in the second to last, or third to last paragraph you refer to poliomyelitis as being associated with this substance fluorine? . . . I got that evidence from Mr Charles Eliot Perkins' valuable book.

I see. I am bound to say this is the first time this suggestion has cropped up. But, do you, yourself, really believe that poliomyelitis is associated with fluorine? . . . It could be. It is not proved one way or the other. It may be.

It is fair to say that you certainly have no real reason for suggesting that it is? . . . I have no—it could easily be and as it affects definitely nervous tissue it is quite likely.

We have referred in paragraph 356 to the fact that Dr Hill did not consider that this inquiry into questions of health should be developed and decided on a scientific basis. The foregoing extract from her evidence appears to us to be an example of her attitude in that regard.

374. We have considered all Dr Hill's evidence with care and we have accepted her invitation to read all the exhibits she made available to us and to take into account the work and conclusions of the various persons she mentioned before us with approval. After examining all this material we are of the opinion that Dr Hill, like her three medical colleagues who gave evidence before us against fluoridation has failed to give proper weight to the findings of many orthodox scientists in all the relevant fields of inquiry and also that to some extent she has been influenced by strong personal feelings on the subject generally.

CHAPTER 43: FLUORIDATION OF THE HASTINGS WATER SUPPLY

375. In stating our conclusions in regard to all the medical questions we have taken into account the whole of the evidence available to us, whether or not certain of the evidence has been specifically mentioned in our survey of particular matters. In this way the issues raised by persons claiming to be adversely affected by the fluoridated water at Hastings and the adjacent township of Havelock North have been considered indirectly in one form or another in earlier sections of this report. Never-

theless, we regard these complaints as an important aspect of this general inquiry and we now give them individual examination. Before doing this it is necessary to establish:

- (1) The date at which the supply was first fluoridated; and
- (2) The efficiency of operation of the scheme.

376. There was some dispute as to when the public water supply in the Hastings district was first fluoridated. Mr Hannah, who at Hastings and Wellington made submissions on behalf of the Public Protection Committee of Hastings, argued that the process was first put into operation in 1949. He said (3G 2):

Sodium silico-fluoride was first added to the Hastings water supply in 1949 per medium of the shovel. This method was discontinued and hoppers introduced early in 1950. . . . In 1950 it started permanently. In 1949 it was being experimented with.

He stated that certain employees of the Hawke's Bay Electric Power Board assisted in the application of sodium silico-fluoride to the water during this period. In this connection he said:

In 1950 the power board introduced sodium fluoride into the water supply. It was only later that the council introduced it.

He produced a photograph of a container marked "sodium silico-fluoride" to support these statements, although he later explained that it had been taken in 1954.

377. An explanation of the way in which fluoridation was introduced at Hastings was given to us by Mr E. R. Whyte, a dental surgeon practising in that city; by Mr R. D. Brown, who was Mayor during the period 1947 to 1953; by Mr W. E. Bate, his successor in office; and by Dr F. S. Maclean, Director of the Division of Public Hygiene, Department of Health. Mr Whyte stated that on behalf of the Hawke's Bay Branch of the New Zealand Dental Association he approached the Hastings Borough (as it then was) Council in March 1951 with the object of persuading the council that fluoridation should be introduced. Through Mr Whyte the council was informed that this process promised to achieve a substantial reduction in the incidence of dental decay, and became impressed with the possibilities. Mr Brown informed us that the council then communicated with the Minister of Health in order to enlist the advice and support of his Department in regard to the matter. The Minister acknowledged this communication by letter dated 17 April 1951. He advised the council that the suggested scheme would be investigated as requested by the council and reported upon at a later date. Eventually a letter was received from the Department of Health, dated 13 March 1952, advising that the proposed fluoridation of the water supply at Hastings had the approval of the Department. The council then instructed its engineer to proceed with the installation of the necessary plant in co-operation with the Department of Health.

378. Reference to these matters was made in the local newspapers from time to time, including an article which appeared on 16 March 1951 at the time of Mr Whyte's first approach to the council indicating that the matter was under consideration. This article is reproduced in Appendix F.

379. Mr R. P. Fish has been the City Engineer at Hastings at all relevant times and included in his duties is control and supervision of the public water supply. He confirmed the evidence given in regard to

all these matters and described the steps which were taken to decide upon and order suitable fluoridation equipment. The plant arrived from England in December 1952, and its installation was completed in January 1953. As we mention in paragraph 433, this original plant was of the "dry feeder" type. The plant was first operated, but on a trial basis, in February 1953, following which certain adjustments were made and then the plant was operated on a permanent basis. A liquid feeder was subsequently ordered and this was installed towards the end of 1954. Mr Fish produced the consignment note for the first supplies of sodium silico-fluoride to reach Hastings, and this is dated 8 September 1952. The supply was obtained from Imperial Chemical Industries.

380. The General Manager of the Hawke's Bay Electric Power Board has been Mr H. H. Wylie during the whole of the period under consideration. He stated that the original fluoridation plant was installed by the Hastings Corporation on power board property, that this plant was electrically operated, and the power board was asked to see that the plant continued working, but only in so far as the electrical equipment was concerned. No employee of the power board took any part in the physical application of the chemical to the water supply or to any part of the plant. Mr Wylie said that the board had never been concerned in the ordering of the chemical. He said he was unable to speak in regard to the activities of his employees outside the terms of their instructions but, when considering whether it was possible that any of the employees had handled the chemical, he said "Well it is possible but very highly improbable".

381. We were impressed by the conviction with which Mr Hannah put before us his opinion in regard to this matter. We are satisfied that he has been sincere in his belief that the water supply in the Hastings district was fluoridated as far back as 1949 and 1950 and we have felt that it was necessary to consider all the evidence with great care. It is our opinion, however, that there is no possibility that the water supply at Hastings was fluoridated before January 1953, and we accept the evidence of Mr Fish that the date upon which the fluoridation plant was first operated was in February 1953, and then on a trial basis. We have reached this conclusion because of the following facts:

- (1) The local branch of the New Zealand Dental Association is responsible for the first suggestions in the district that the water supply be fluoridated. The date of its approach to the Hastings Borough Council is fixed by the evidence of Mr Whyte and Mr Brown, and confirmed by the council minutes. The approach was made in March 1951.
- (2) The Health Department had had no approach from the local body prior to that time; following the council's request for advice and assistance a year passed before the Department was prepared to give its approval to the proposed scheme.
- (3) The type of public water system at Hastings makes it quite impossible for any regular addition of the chemical to be carried out manually.
- (4) The fluoridation plant did not reach Hastings until December 1952, and was not installed until January 1953.
- (5) The first supplies of the chemical to reach Hastings arrived some time after 8 September 1952.

It may be that confusion has arisen in regard to the date of commencement of fluoridation in the Hastings district by reason of the announcement in the newspapers in March 1951 that such a scheme was under consideration.

382. The efficiency of operation of the fluoridation plant was discussed by Mr Fish, and results of water analyses were made available by Mr James of the Dominion Laboratory. As is mentioned in paragraph 433, the dry feeder caused slight variations in the supply and, for this reason, the concentration of fluoride in the water was kept below the optimum level. When the liquid-type feeder was introduced at the end of 1954 the reason for these slight variations was removed, and since that time the concentration of fluoride in the water has been maintained at 1 ppm as is established by the water analyses. Confirmation of this is contained in the results of the analyses of certain 24-hour urine specimens taken from six adult subjects in 1955. These gave values lying between 1.18 and 1.49 milligrams of fluorine for daily excretion in urine. These values are slightly above 1 ppm because, of course, the excretion includes fluorine originally absorbed from food and tea. The samples show clearly that these subjects were ingesting the desired amount of fluoride from all sources.

383. Some anxiety was expressed by certain witnesses, including Mr Gamble (7), Mr Moore (2W 2), and Mr Boulton (5J 1), lest higher concentrations of fluoride might arise "at the lower end of reticulation systems" or in pipes if the service was not used for a period. It was stated also that there was no certainty that the fluoride would be evenly distributed throughout the whole water supply.

384. The efficiency with which water-works installations have been able successfully to apply other chemicals to water is discussed in Chapter 49. The regular analyses of water taken from various parts of reticulation systems where fluoridation is in operation overseas show conclusively that this substance likewise can be and is evenly mixed in the water supplies. These facts are confirmed by the experience at Hastings itself. It is established, moreover, that once this mixing of the fluoride ions takes place in the water there can be no subsequent "accumulation" of the ions in any part of the water reticulation.

385. In determining the optimum level of concentration of fluoride in drinking water account is taken of all the uses to which the water will be put, including the processes of cooking. In this regard fluoride will concentrate in water as it is heated in the sense that the remaining water, after portion has been drawn off in the form of steam, will contain the total amount of fluoride which was in the original quantity of water. For example, 1 quart of water containing 1 ppm of fluoride can be reduced by heating to 1 pint of water containing 2 ppm of fluoride. In this example the quantity of fluoride has not increased, of course, but a change has taken place in the concentration merely because the quantity of the water has decreased. This has no significance in regard to human ingestion, however, since it is the overall daily consumption which is the determining factor and not the rate at which it is consumed.

386. For the reasons explained in the foregoing paragraphs the complaints made before us in person or in the letters produced by Mr Penlington are concerned with a process which was first operated in February 1953 and which has had the effect of keeping the level of fluoride in the water at or slightly below the optimum level of 1ppm.

CHAPTER 44: COMPLAINTS ARISING FROM THE FLUORIDATION OF THE HASTINGS WATER SUPPLY

387. We have stated in paragraph 347 that complaints concerning the effects of drinking or washing in fluoridated water at Hastings came before us in two ways.

- (1) Certain individuals gave evidence in person claiming that they had suffered adverse effects.
- (2) Mr W. A. G. Penlington produced twenty-five letters containing similar complaints and most of which had been collected by him in August 1954. Two letters were additional ones to the letters referred to specifically in the evidence.

It is the position that, with one exception, all the letters appear to have been written at least 2½ years ago; that five of these are extracts from the correspondence columns of the *Hawke's Bay Herald-Tribune* (three of these being anonymous); and that three were written by witnesses who appeared in person before us. These facts have caused us to consider whether the letters have any evidentiary value at all. Throughout this inquiry, however, we have thought it necessary to ensure that nothing was excluded which might have some bearing on the wide questions in issue and, for this reason, we have given these letters a rather more careful examination than otherwise we would think they deserve.

388. There were 13 witnesses who appeared before us with complaints that the fluoridated water at Hastings had distressed them in one form or another. Of these one was Dr Eva Hill, who visited Hastings for a few days. The general evidence she gave on medical grounds is discussed in some detail in Chapter 42. Another of these 13 witnesses was Mr P. L. Souter, a student who normally resides in Auckland but who visited his friend, Mr Penlington in the Hastings district, during the Christmas period in 1954. The other 11 witnesses are residents in the area and one of these, witness No. 5, claimed to have had it confirmed by medical advice that her illness was due to fluorine poisoning.

389. A tabulation of the complaints made by the 11 residents of Hastings or Havelock North is as follows:

<i>Witness No.</i>	<i>Sex</i>	<i>Complaints</i>
1	F	In July 1953 – quite unaware that our water supply was being medicated, and after drinking extremely bitter tea and many glasses of tasteless but peculiarly harsh water – I became ill with the most distressing symptoms – extreme nausea, mental and physical inertia, I lost the use of my limbs and also suffered impairment of my eye sight. I went on drinking water and began vomiting. I lost the use of my limbs and could only stagger. Opinion expressed that she had a fluoride allergy.
2	M	Uneasiness but no complaints.
3	F	Attack of nausea and retching attributed to water although attack occurred when the resident was at Woodville.
4	M	Symptoms consistent with fluoride poisoning. (not specified.)

<i>Witness No.</i>	<i>Sex</i>	<i>Complaints</i>
5	F	Bad skin condition and slowly progressive ill health.
6	M	Gastric and gastro-intestinal disturbances.
7	F	Adult minds influenced by the fact that a potent poison is administered in the drinking water even if only in small quantity. No physical complaints.
8	F	I am now depriving myself of an essential large intake of water because of fear.
9	F	Dry mouth. Disturbed or uneasy in mind.
10	M	I have throughout my life enjoyed extremely good health until. . . I have also and still do lead an active life but I have noticed many unusual symptoms of minor ill health not compatible with middle age since having ingested fluorides in the local mass medication. These included thirst, sore and itchy throat, dryness of mouth, brittleness of finger and toe nails, cramps in extremities to a minor degree, the dropping of small objects, skin trouble, impaired mental energy, diminution of sight, and lessening of the feeling in the fingers. In so far as my family are concerned, my wife who enjoys reasonably good health and is not of a nervous disposition has been caused distress as a result, we are positive, of the effects of using fluoridated water in 1953, 1954, and 1955. She suffered from sore throat, sore eyes, undue thirst, minor cramp, and a tendency to drop small things. Also a vital matter causing real and permanent distress to her was the further impairment of her hearing.
11	M	Disorder of the spine. Allergic to fluoride.

390. The complaints made by Dr Eva Hill and Mr Souter are listed separately as they were not residing permanently in the district. It will be observed that, unlike any of the other witnesses, Dr Hill's reactions to the fluoridated water arose not from drinking the water, but from using it for washing or cleaning teeth. The relevant statements of these two witnesses are as follows:

Dr Eva Hill: My own eyes were painful and my lips inflamed after four days in your town.

If I might add a personal touch here, I have had experience in two artificially fluoridated cities—the town of Hastings in New Zealand and Pittsburgh, Pennsylvania, where I spent a week recently. In both those cities my reactions were the same. I am not allergic, in the ordinary way, to anything, but I did not drink the Hastings water — but from only bathing, washing my face and cleaning my teeth with it, in a week my face was hardly fit to be seen, and the same occurred in Pittsburgh. After a week in Pittsburgh, where I also did not drink the water or eat food boiled in it — it was a job getting sufficient nourishment — but I had to bath and clean my teeth with it, and my lips were swollen to three times their ordinary size and the lower one almost completely skinned. So I hate to think what would happen if I had to drink fluoridated water.

Mr P. L. Souter: After I had drunk the water I was aware of a burning sensation in the back of the throat. It was a peculiar sensation not unlike hiccupping bile into one's throat after indigestion.

391. An analysis of the symptoms listed in the letters is as follows:

	<i>Number of Times Complaint Made</i>
Referred to the mouth and throat	28
Dry and/or sore mouth	14
Dry and/or sore lips	5
Dry and/or sore throat	9
Referred to the gastro-intestinal system	8
Nausea	1
Vomiting	1
Indigestion	1
Irritation of mucous membranes of intestines	1
Abdominal pain	2
Alleged effect on gastric ulcers	1
Baby's digestion	1
Referred to the nervous system	7
Lassitude	3
Lack of concentration	1
Numbness	1
Aggravation of deafness	1
Sight	1
Referred to the respiratory system	3
Cough	1
Pain in the chest	1
Shortness or breath	1
Referred to the skin	2
Irritation	1
Urticaria and infection	1
Referred to the joints	2
Pains	1
Arthritis	1
Irritation of the eyes	5
Increased thirst on drinking water or tea.	1
	<hr/> 56

Two correspondents complained of allergy.

392. It will be observed that most of the complaints listed in the three preceding paragraphs are recognisable as elements of the Waldbott-Spira syndrome which we have examined in detail in Chapters 36 to 41. Indeed, the ailments enumerated by witness No. 10 describe the elements of that syndrome with a high degree of precision. We have expressed our conclusions that there is no causal relationship between the alleged symptoms of the syndrome and ingestion of water containing 1 ppm of fluoride (para. 345). It becomes necessary to refer to the features of the complaints arising from fluoridation at Hastings.

393. We have mentioned that, with one exception, the letters were collected by Mr Penlington in 1954. He wished to use them in support of the petition of himself and ten others which had been presented to Parliament and which prayed that steps be taken to prevent sodium fluoride being added to water supplies. The report of the Select Committee, which had no recommendation to make, was presented on 11 August 1954. Of the letters, five had been written in 1953 or early in 1954 and all these had appeared in the correspondence columns of the local newspaper. All the others appear to have been written in the first few days of August 1954, the latest being dated 9 August.

394. Apart from the letter written in April 1957 no correspondence of recent date complaining of the effects of fluoridated water at Hastings reached us from any source. There were 13 witnesses who appeared

before us in person to make such complaints, and of these two were not residents in the district. If these various complaints are in fact representative of a generally uneasy situation existing in Hastings and Havelock North, then we are surprised that so few troubled to describe their symptoms and experience.

395. Mr Bate gave evidence that, in his capacity of Mayor of Hastings, he promised in February 1954 that if any person produced a medical certificate indicating that some ailment was due to fluoridation he would have the matter referred immediately to the Director-General of Health. We think it significant that no person has ever come forward with such a medical certificate, either through Mr Bate or to the Department of Health directly and no certificate was submitted to us. Mr Woodhouse asked Mr Penlington about this matter in relation to the letters. The extract follows (3C 2):

I have attempted to go quickly through these letters. Is it a fair summary of the facts contained in regard to these various persons, that virtually none of them, if any, had actually gone to a medical man themselves . . . I think that could be said. In most cases they suspected it was the water and they stopped drinking it and felt all right. One or two went to a doctor and he said, I think, that they had better try other water, but I am not saying that the doctor proved it was the cause of fluorine.

I was just concerned that some request may have been made to the Department of Health to investigate these on any formal basis. That wasn't done, was it? . . . I am not aware of it, no.

396. In Wellington, Mr Penlington expressed the opinion that "no doctor qualified to diagnose incipient fluoride poisoning was available"; and that the people of Hastings were faced with "a new man-made disease, incipient fluorine poisoning, which is outside the range of the ordinary medical practitioner though the allergist and the specialist have pointed to it". The last allusion is, no doubt, to the opinions of Dr Waldbott and Dr Spira.

397. We do not agree with the implication contained in Mr Penlington's remarks that the local doctors were incapable of dealing with the possibility of fluoride poisoning. The President of the Hawke's Bay Division of the British Medical Association, Dr McPherson, stated that on 22 March 1956 the following resolution was passed at a meeting of his division:

That this meeting reaffirms that on the basis of the available scientific evidence, and from local medical experience, there are no grounds for believing that the artificial fluoridation of the Hastings municipal water supply produces any deleterious effects whatsoever on the human constitution.

Dr McPherson was authorised by his association, at a meeting held on 15 November 1956, to say that "none of the twelve doctors present at the meeting had seen any cases with symptoms suggesting fluoride poisoning".

We are satisfied that the local doctors had considered in a responsible manner the need to watch for any symptoms which could possibly be related to fluoride poisoning. The evidence shows clearly that they rejected the possibility that the fluoridated water at Hastings could produce any harmful effects on the health of the inhabitants.

398. Excluding two special cases (witnesses 5 and 11) which we consider separately (see paras. 405 to 411), another feature of the complaints which have been made is that they all relate to common ailments of a minor nature which could and do arise from many causes; and related to this is the fact that most witnesses have expressed their general reaction to fluoridation as ranging from doubt or uneasiness to actual

fear. Examples of this attitude are the statement of one witness that she was "depriving herself of an essentially large intake of water because of fear"; of another that "this situation regarding the contamination of fresh and wholesome water is creating doubt, fear, alarm, and other complexes"; by another there was reference to "the natural instinct for self-preservation"; and another witness said that fluoridation occasioned "mental perturbation in a varying degree"; another that "some persons have been overwrought".

All these expressions of anxiety were summed up by two witnesses in Hastings. Mrs Cater said:

I would ask you to consider the larger age group of the *adult* population who should be covered by a doctor of psychology to present the case of those whose minds are sick, through the influence of a fact that a potent poison is administered to them in their drinking water – even if this is in a small quantity only.

Mr Gamble put the matter in the following way:

Healthy persons can be made ill if, with good reason, they believe fluoridated water to be harmful to them.

399. All these statements have assisted us to reach some understanding of the situation that developed in Hastings. In all cases the expression of anxiety has arisen out of a firm belief that fluoride is a potent poison and in some cases witnesses have expressed their fear openly. Others have stated that this fear of harm can have in fact a harmful effect on the mind (Mrs Cater) and be the cause of illness (Mr Gamble).

400. It is well known that fear – conscious or subconscious – can bring about bodily manifestations which may express themselves in many different ways. This is a "psychosomatic" effect, and brought about by the influence of emotion on bodily functions. We are satisfied that such effects may become manifest if people are made to believe that fluoridation is a means of conveying poison to them. In Dunedin, Professor Walsh said (6N 1):

If such people drink fluoridated water they could undoubtedly develop symptoms which are quite real to them, symptoms which to them are not imaginary. The correct term for such symptoms is "psychosomatic" or "psychogenic". Modern medicine recognises and accepts the fact that disturbances of the mind and emotions will in some people produce bodily symptoms. To give you a simple and relevant example – fear causes a dry mouth because fear inhibits the flow of saliva. One of the symptoms described by these people opposed to fluoridation is that they get a dry mouth when they drink fluoridated water. Many of the other symptoms described by this group have a similar explanation. I emphasise that these symptoms are real to the person involved and may indeed produce objective signs which can be recognised by other persons.

We agree with Professor Walsh and accept the general principle of psychosomatic effects. We are satisfied also that any influence in the shape of publicity or propaganda, which is charged with emotional significance for the sufferer, will reinforce the belief in the poisonous character of fluoride and strengthen an emotional commitment to oppose fluoridation.

401. In considering the effect upon the Hastings people of any fluoridation publicity we have not overlooked the opinion expressed by Mr Penlington (9N 5) that "The complaints were the cause, not the result of the anti-fluoridation movement". There is no doubt that by February 1954 when Mr Bate gave his assurance in regard to the production of a medical certificate (para. 395) there had been for some time considerable public discussion of fluoridation. This continued for some months afterwards, and samples of anti-fluoridation publications

which were circulated at this time were produced to us. They included for example *Fluoridation Facts* compiled by A. Wilkinson, which contains highly exaggerated and misleading descriptions of the fluoridation process. Other publications contained similar highly coloured statements. After considering the manner of expression of the complaints made in the letters produced by Mr Penlington and also the evidence given verbally we are satisfied that the complaints have been influenced by the public discussion of fluoridation which took place in Hastings and by misleading anti-fluoridation propaganda. We think it is significant that a dry, sore mouth and a dry, sore throat were so frequently complained of and that descriptions of the ailments were often in terms which resembled closely the descriptions given of the Waldbott-Spira syndrome.

402. Although we are of the opinion that the general emotional atmosphere in Hastings was conducive to the manifestation of psychosomatic disorders it will be appreciated that there may well be unrecognised physical causes for some of the ailments which were described to us. Indeed, we feel satisfied that some of the ailments so described to us have had a physical cause in no way related to any emotional background. We think they have been ascribed to fluoridation only by reason of the general discussion of the subject that has taken place. This would explain, in our opinion, the ailments suffered by those few witnesses who at the time were unaware that fluoride had been added to the water.

403. It appears to us therefore that evidence given on these matters was a genuine expression of belief by the witnesses concerned. We were impressed by their sincerity. We are satisfied, however, that their disorders were not due to the fluoridated water at Hastings but to their acceptance of inaccurate and misleading information on the subject.

404. We do not consider the atmosphere at Hastings to have played any substantial part in regard to the symptoms described by Mr Souter or Dr Hill who merely visited the town. Mr Souter, however, stayed with Mr Penlington who has taken a prominent part in the anti-fluoridation campaign in the district. This visit took place at Christmas 1954. Dr Hill on the other hand has been much involved in the subject as we have described earlier in this report.

405. It remains to consider two other cases which have special features. The first is witness listed as No. 11 in paragraph 389. He complained, *inter alia*, of a special disorder and stated that this developed in 1951 after drinking, as he thought, the fluoridated water. Dr Costello informed us, with his permission, that he was suffering from degeneration of a vertebral disc which we understand to be a fairly common disorder in middle-aged men. We have no doubt whatever that this witness has a sincere belief in all the matters he put before us. Mr Woodhouse, in his final address before us, suggested that people are at times mistaken even when their beliefs are held most sincerely and that perhaps this witness would be relieved if it were quite certain that he had been wrong in these matters. We have examined with care the considerable quantity of evidence he made available to us and we are satisfied that he has not been adversely affected by the fluoridated water. We are confirmed in this opinion, which has been independently reached, by the fact that the illness of which he complains developed prior to the date at which fluoridation was first inaugurated in Hastings. This, as we have stated in paragraph 386, did not take place until February 1953.

406. The other case is the witness listed as No. 5 in paragraph 389. She described her disorder in the following way:

My ill health took the form of a very bad skin condition and slowly progressive ill health which continued until I decided, after everything else had been tried, that it must surely be due to fluoridation of the water supply.

Cross-examination revealed that the illness began in January 1951, and that the witness had used fluoridated water from the date of inception of fluoridation until about 6 January 1956. The witness moved to a nearby non-fluoridated area on 21 April 1956. The witness said:

. . . with the aid of two New Zealand doctors and a private technologist I secured *pathology* through a proved method of blood fluorides. As a result these New Zealand doctors diagnosed fluorine poisoning and advised removing from the fluoridated area. Today, my health is restored and I have not had a bad "blow up" of the skin condition since I gave up drinking fluoridated water.

We understand that by the use of the word pathology the witness was intending to refer to certain laboratory analyses. The witness submitted as exhibits the booklet *Fluoridation Unmasked* by Fanchon Battelle, and five letters including two from Dr L. Spira of New York.

407. This is the only case brought to our notice in which there is a claim that laboratory tests have confirmed fluoride poisoning. With the helpful co-operation of the witness we have had access to the information relating to these tests. The first was a urinalysis which was carried out by the Dominion Analyst 2 months, as she assures us, after she had ceased drinking fluoridated water and 1 month after she had commenced to avoid foods rich in fluorine on the advice of Dr Spira. We accept her assurance in these respects. The sample of urine contained 1.9 ppm of fluorine but was not a 24-hour sample. The witness considered that as she had avoided ingesting any significant quantity of fluoride this result showed that she had been accumulating a toxic quantity of the substance earlier and that this was derived from the fluoridated water.

408. Assuming as we do that the witness had a low-fluoride intake it would be expected that the excretion of fluoride would be correspondingly low two months after she had ceased to ingest fluoridated water. On this point, however, there is no evidence despite the test of urine. The sample analysed would merely give the concentration of fluoride at the particular time of day when the urine was eliminated. Dr Bell (2F 1) stated that it is impossible to calculate the total daily elimination of fluoride from such a test because the concentration varies widely from time to time during the day. We accept this evidence. The analysis in this case is not a test of the urine over 24 hours and does not show that the daily elimination of fluoride in the urine was greater than the assumption we have made would permit.

409. The other test relied upon by this witness as evidence of fluoride poisoning was a blood test. It appears, however, that some confusion has arisen in regard to this as the test itself produced a negative result. The analyst tested samples of water and urine on the same occasion. No doubt the witness has confused the positive result of one of these analyses with the negative result obtained from an analysis of 10 c.c.s of blood by the method described in the *B.D.H. Book of Organic Reagents for Analytical Use*, 9th Ed. (1947) at pages 4 to 6. So far as the test of urine is concerned we are informed by one of the witness's medical advisers that the sample contained 2 micrograms of fluorine in 184 c.c.s

of urine or 0.01 ppm. If this analysis is correct, the urine was virtually free from fluorine. Again, however, this sample appears not to have been a 24-hour sample.

410. We have mentioned that this witness produced to us the booklet by Fanchon Battelle which is typical of much anti-fluoridation propaganda, and in many respects is misleading and inaccurate. In addition, she has indicated that she relies on the opinions and suggestions of Dr Waldbott and Dr Spira regarding chronic fluorine intoxication which we have felt obliged to criticise in Chapters 36 to 41. These facts suggest that this witness may well have developed psychosomatic effects in the course of her illness. Indeed, Dr Spira himself has stated in his letter of 6 April 1956:

I know that, being a victim of chronic fluorine poisoning, you are bound *subconsciously* to be influenced by what is going on and by what has been found. I shall be glad to know that this letter is helping you to obtain a clearer picture of the happenings in the course of the disease.

411. The illness of this witness began in January 1951, and its cause can have no relation to the fluoridation of the public water supply at Hastings and Havelock North, which began in February 1953, as we have stated in paragraph 386. Apart from this fact the analyses of urine for fluorine give no information regarding the daily excretion and, for this reason, do not support the belief of the witness that she was excreting fluoride from a cumulative store in the body. On the other hand the blood test produced a negative result. We are satisfied that the witness is sincerely convinced in her opinion that fluoride is the cause of her illness but, in fact, there is no evidence to support her opinion.

CHAPTER 45: GENERAL CONSIDERATIONS

412. The witnesses who appeared before us to complain of the adverse effects on their health of the fluoridated water at Hastings were completely genuine and sincere in their beliefs as we have stated in the previous chapter. It is our conclusion, however, that these witnesses have not been adversely affected by the fluoridated water. We think that in some cases they have been affected by the nature of certain propaganda to which they have been subjected. Throughout this report we have been obliged to make reference to the considerable quantity of this anti-fluoridation propaganda which has come to our notice and which appears to have an increasing circulation in this country. Substantially it takes the form of pamphlets, booklets, and leaflets printed in the United States of America, supplemented by a few smaller publications printed in Australia or New Zealand. Wherever printed, however, the information contained in this material appears to have its source in the United States. We have provided numerous examples of the unreliable nature of this information. Much of it, however, has been put before us as coming from authoritative and reliable sources and we are satisfied that much harm can come from its uncritical acceptance.

413. Some of this propaganda has a high emotional content and is designed to frighten unthinking people. The more sensational and absurd statements appear under headings such as:

Fluoridation is MASS MURDER
 What is Harmless to Some May Kill Others
 Communism via the Water Tap
 Fluoridation is Communist Warfare

Other captions such as "Fluorine is Used to Etch Glass" or "Fluorides Will Shorten Your Life" carry an implication which appears to us to be deliberately misleading. This type of propaganda is entirely irrational and has no relevance whatever to the subject of fluoridation.

414. Apart from this propaganda couched in sensational terms is a type of polemical writing which frequently puts forward incorrect information as if it were factual; or provides correct facts but argues to an incorrect conclusion from them. In other cases correct information is twisted out of its context. All this has the effect of misleading many genuine people of an inquiring turn of mind. Those who would check the statements for themselves frequently do not possess sufficient qualifications to evaluate the material or have no access to the means of checking. This propaganda has caused some people to doubt and distrust both the motives and the objective work of first-class scientists and administrators in the United States and elsewhere. We regret that certain doctors have indulged in this type of writing.

415. Finally, there are the extracts taken from the writings of Dr Waldbott and Dr Spira which have received wide publicity, but which contain no hint of the speculative method of reasoning upon which the conclusions are based. Few people have access to the original publications of these doctors in medical journals and even fewer would have the qualifications or the time to analyse the results and reasoning contained in them. Descriptions of the signs and symptoms which these doctors allege to be due to incipient fluorine intoxication (and which, as we have shown, do not have the causal relationship claimed for them) have been readily available to the interested section of the public. These facts have given rise to unnecessary confusion and anxiety.

416. All these various influences have been at work in Hastings where the Hastings Anti-fluoridation Society has taken a prominent part in placing the matter before the public. Similar bodies have disseminated propaganda in other centres. We have no doubt that the propaganda material which has been distributed in Hastings and elsewhere, or acquired by citizens for their own information, has done much to arouse fear of fluoridation in the minds of receptive persons and to create an emotional state in which people become unduly responsive to the suggestion that they are suffering from minor ailments that can be attributed to fluoride. We are satisfied that the anti-fluoridation movement in Hastings has unwittingly played a part in creating an atmosphere conducive to the development of bodily disorders which are secondary to mental perturbation.

417. In discussing the possible hazards of fluoridation, witnesses on both sides have made statements intended to prove that the process is either gaining or losing ground in other countries and particularly the United States of America. The answer to this question cannot be given undue importance in deciding the general issues involved, but we have examined the position for what it is worth.

418. Several witnesses opposed to fluoridation stated that many communities in the United States have refused to introduce fluoridation and that some have rejected fluoridation after it was introduced. In considering these suggestions certain of the witnesses who support the process confirmed some of the statements, but they added that such

decisions were the result of the activities of highly organised anti-fluoridation groups. We are unable to decide the validity of that view, but we think it likely that those activities would have a considerable influence in the matter.

419. Dr Eva Hill made a rather sweeping allegation to the effect that fluoridation is a failure in the United States and is on the way out. Others have expressed a similar opinion and have referred us to numbers of communities which have rejected the proposals. Apart from the wide range of estimates of this nature which have been put before us (the numbers vary from 57 to over 600) we consider that numbers of communities unaccompanied by numbers of population are rather meaningless figures. We have had resort therefore to the following quotation from *Civil Engineering* (1956):

The United States Public Health Service reports that in the first 9 months of 1956 water systems serving 6,000,000 people started fluoridation of their supplies to protect children's teeth. This compares to an average annual increase of 4,000,000 users during the period 1951 to 1955.

Nearly 45 per cent of all communities of over 500,000 are fluoridating their supplies – among them Chicago, Philadelphia, Washington, Cleveland, San Francisco, and St. Louis. New York City is currently weighing the pros and cons.

A similar statement appears in *Public Health Reports* (1957), published in the United States. These statements were confirmed by several witnesses who testified in favour of fluoridating, including Colonel Fuller, Dr Davies, and Miss M. McLean, a councillor of the Christchurch City Council, who recently returned from the United States.

420. In the United States about 3,000,000 people live in districts where the *natural* concentration of fluoride in the water supplies is approximately 1 ppm or more. As a result of the introduction of artificial fluoridation, the total number of people consuming fluoridated water in the United States is now somewhat over 30,000,000, and the populations of such large cities as Chicago, San Francisco, Cleveland, Philadelphia, Pittsburgh, and Washington, D.C., are included in the total.

421. The British Government has approved the policy of setting up four demonstration areas. The areas selected were Anglesey, Darlington, Watford, and Kilmarnock, but in Darlington opposition to the measure led to a hostile press campaign and the local authority decided not to proceed. We are informed that Andover is to replace Darlington. By the end of 1955 fluoridation had commenced in Anglesey and preparations were almost completed in Watford and Kilmarnock.

422. Elsewhere fluoridation studies have been inaugurated in Sweden (Norrköping), Germany (Kassel), Holland (Tiel), Belgium (Assesse), New South Wales (Yass), Tasmania, and probably several South American cities. Reference has been made in Chapter 10 to the fact that in 1945 Brantford became the first city in Canada to undertake fluoridation. The interpretation of certain legislation has had the effect of preventing fluoridation in some areas, but there are a number of other communities with fluoridated supplies in that country.

423. We are satisfied that statements that fluoridation is not extending in the United States are unreliable and that in fact steady progress has been made in that country with the extension of the process. Similarly, many suggestions that fluoridation of water supplies has been totally banned in various countries are also not supported by the facts. An example of this is the statement that it has been banned in Sweden.

This is refuted by a letter (Dr Hilge Bergen, Director of the Eastman Dental Institute in Stockholm to Mr T. G. Ludwig, Wellington), which was tabled before this Commission.

424. In evidence given at Hastings Dr Mangos stated that the New Zealand Dental Association had approved fluoridation and actively supports what it regards as one of the most important public health measures of our time. This approval was reiterated by representatives of the association's branches and of various New Zealand Divisions of the British Medical Association. Colonel F. J. Fuller and Dr Muriel E. Bell referred us to well known authoritative organisations that have approved fluoridation. They include the recognised medical and dental associations of the United States, the United Kingdom, Australia, and Canada; the American Association for the Advancement of Science; and the National Research Council, National Academy of Sciences, U.S.A. (1951). The World Health Organisation has also approved the process as have the public health services of various countries.

425. We have referred earlier to the confident endorsement by Dr Bell of fluoridation (para. 254). That her opinion carries weight in the subject of fluoridation is shown by the fact that Mitchell and Edman (1953) in referring to "the immense volume of literature" on the subject state that this "has been well reviewed by Harrison and Bell in New Zealand, Arnold in the United States, and by Weaver and MacKinnon in England".

426. Dr Bell's opinions were confirmed by Sir Charles Hercus. In expressing his own views on the value of fluoridation he said:

I haven't worked with the element (fluorine) as I have worked with iodine, but in 1952 I had the privilege of going to Washington and I particularly debated this question with the then Director, Dr Dean, who had done a great deal of work in this field, and I was rather debating it from the opposite angle in order to bring out the facts, and I came away convinced that the experimental data they were able to put before me showed two things clearly. One was that the procedure was entirely rational and the other was it was completely safe.

427. An impressive fact in our opinion is the following endorsement of fluoridation which comes from the Minister of Health in the United Kingdom and which we take to represent the policy of the United Kingdom Government (Report of the Ministry of Health, September 1956):

The Government's policy in arranging demonstrations of fluoridation has received support from a number of important professional bodies including the British Dental Association, the Public Health Officers' Committee of the British Medical Association, the Society of Medical Officers of Health, the Faculty of Dental Surgery of the Royal College of Surgeons, the Medical Research Council, and the Standing Medical and Dental Advisory Committees of the Central Health Services Council.

During 1955, several reassuring reports were published in North America giving the results of 10 years of fluoridation. These results show consistently a reduction of 50 to 60 per cent in the rate of dental decay in children brought up in the fluoridation areas, and they reveal no evidence of ill effects of any kind.

In the light of the reports on the North American studies, and of other evidence that water containing 1 part per million fluoride has no ill effects, it has become evident that some of the medical examinations which were envisaged by the United Kingdom Mission are not necessary. Research will, of course, continue so that more may be known of the mechanism, by which fluoridation achieves such a beneficial reduction in dental decay, but this will be an effort of pure research, not a measure taken because there is any likelihood of danger.

As an additional check, comparisons have been made in this country of vital statistics in high- and low-fluoride areas, and the following rates have been studied: neo-natal and infant mortality rates; still-birth rates; death rate from all

causes; death rates from kidney disease (nephritis and nephrosis); cancer (all forms); ulcer of the stomach; cardio-vascular diseases; cancer of the stomach; and cancer of the breast. In none of these were there any differences between high- and low-fluoride areas which could be interpreted as indicating any harmful effect on health, nor even a slight pointer to the need for any further studies to demonstrate this.

To deal satisfactorily with an increasing number of inquiries about fluoridation a reference note was prepared and made available to professional people in the areas where it was planned to carry out demonstrations. In this note it is particularly stressed that fluoridation has already passed the experimental stage and that it is essentially an effort to co-operate with nature since nothing of a chemical nature which is not already present in many water supplies is being added. The aim is to increase the fluoride content of water to a level at which, while doing no harm at all to general health, it is known to improve the condition of children's teeth.

428. Our own inquiries have satisfied us that fluoridation of water supplies is a procedure which involves no hazard to health. We summarise our conclusions in this regard in the following chapter.

CHAPTER 46: SUMMARY OF OUR CONCLUSIONS ON THE RELATION OF FLUORIDE TO GENERAL HEALTH

429. We regard the following matters as established:

- (1) The process of fluoridation does not add a substance that is foreign to the water, but merely brings about a slight change in the concentration of the fluoride already present naturally in that water.
- (2) No diet is devoid of fluoride and water is the normal vehicle for conveying this substance to the body.
- (3) Fluoride is a normal constituent of bones and teeth.
- (4) Fluoride is a nutrient and is beneficial in proper amounts. In common with many other foodstuffs it has adverse effects on the body when ingested in excess.
- (5) In the proposal to fluoridate public water supplies there is no risk of excessive ingestion; there is no risk of chronic fluoride poisoning; and the possibility of acute poisoning can be disregarded entirely. Suggestions to the contrary in some anti-fluoridation propaganda are misleading and absurd.
- (6) No harmful effects on health will follow the fluoridation of water supplies whether in respect of the complaints specifically made before us or otherwise.

Part VII

MECHANICAL CONSIDERATIONS IN REGARD TO FLUORIDATION

CHAPTER 47: GENERAL CONSIDERATIONS

430. We have discussed in the foregoing parts of this report all the dental and health questions which arise out of the proposal to fluoridate public water supplies. It is necessary now to decide whether the process can be carried out accurately and efficiently. This involves a number of individual matters. They include:

- (1) Choice of the compound of fluoride to be added to the water.
- (2) The type of apparatus to be used.
- (3) Tests to ensure maintenance of the desired concentration of fluoride in the water.
- (4) Methods of handling the chemical.
- (5) Effects on water reticulations and industry.
- (6) The desirability of setting up a body to control and regulate proper standards in fluoridation plants.

431. In this part of our report we make reference to a suggestion that fluoride could be removed from the water. This is said to be practicable either on a community-wide basis to reduce a high natural concentration to the optimum level, or on a domestic scale for the purpose of enabling those persons to avoid fluoridated water who did not want it.

CHAPTER 48: THE CHOICE OF FLUORIDE COMPOUND TO BE USED

432. We have described in Chapter 20 the fact that neither the element fluorine nor any organic compound of the substance is relevant to the subject of fluoridation. The agent effective in reducing the incidence of dental decay is the fluoride ion which is to be found in all natural waters. We have explained also that all ions of fluoride, no matter what their source, have identical properties both in a chemical and a biochemical sense. It follows, therefore, that any of the inorganic compounds of fluoride which will ionise in water will exert a similar effect.

433. At Hastings sodium silico-fluoride was first used in conjunction with two vibrator-type dry feeders (see para. 442 *infra*). This compound has been used widely overseas, but experience at Hastings suggested that the dry feeder was best suited to a much larger plant. Mr Fish, the City Engineer at Hastings, informed us that the material was inclined to clog in the hopper and, for this reason, it was difficult to keep a uniform flow. During this period the quantity of fluoride introduced into the Hastings water supply was kept below the proposed or optimum level.

434. A decision was made to install at Hastings a solution feeder (see para. 443 *infra*) suitable to the size of the water service and at the same time the fluoride compound was changed to sodium fluoride. This change

in the compound of fluoride to be used was made because sodium fluoride has a greater solubility. The combination of solution feeder and the use of sodium fluoride has worked with complete accuracy and satisfaction in Hastings since its installation.

435. The two compounds, sodium fluoride and sodium silico-fluoride, are by far the most commonly used of the compounds of fluorine in fluoridation plants. Mr S. K. Johannesson is chemist in charge of the Wellington City Council laboratory and responsible for the examination and testing of the city's water supplies. He informed us (9T 4) that quite recently one of the natural minerals found in the earth (fluorspar) had been suggested and was being processed for the purpose of fluoridation. In this connection he referred to a recent paper of Maier and Bellack (1957) which recommends the use of fluorspar and its addition to the water as part of the normal treatment of the water already carried out at many water works.

436. The choice of compound to be used will depend upon such factors as availability, cost, solubility, and the size of the plant required. We have mentioned that sodium fluoride, for example, is more readily soluble than sodium silico-fluoride. It is, however, more expensive.

The report of the United Kingdom Mission (1953) indicates that when cost is related to solubility, the real cost in the United States of the sodium fluoride compound is about four and a half times that of sodium silico-fluoride. This factor would vary from time to time and country to country. At Hastings there was a low figure of slightly less than 1s. *per capita* for all operational costs including the compound used.

437. Mr Johannesson stated that in the United States the cost of the natural mineral fluorspar was about one-third of sodium silico-fluoride, but its effective cost would depend upon whether other treatment was already being carried out as a water works and also its landed cost in this country.

438. We have mentioned in paragraph 436 that one of the factors that would determine the choice of the compound is the size and type of plant to be used. This in turn depends upon the water consumption of the community concerned and any factors peculiar to the type of the supply. Owing to fluctuations in prices of the chemicals and the other considerations we have mentioned, it is not possible to recommend, without some qualification, the use of a particular compound of fluoride. The matter is one of some importance, but we are of the opinion that a decision of this nature should be reached after proper examination in each case. We think this should be done on the advice of a national body set up for the purpose of assisting with and regulating fluoridation projects.

CHAPTER 49: PRACTICABILITY OF FLUORIDATING WATER SUPPLIES

439. Many water supplies already receive extensive treatment. Chemicals are added to the water not only for the purpose of removing noxious substances, but also to make the water more palatable or of better appearance. In the case of Auckland city, Mr Firth, the water-works engineer, stated (4Y 2) that the water supply was first dosed with alum (sulphate of alumina) to remove colouring and suspended matter,

filtered to remove the resulting flocculated material, lined to neutralise acidity, and whenever necessary chlorinated as well. The equipment used for these purposes requires, for obvious reasons, to be precision apparatus, and undoubtedly suitable equipment of this kind has been in use for many years. The addition of fluoride to drinking water presents no new or unusual problem in water-works engineering, and several types of apparatus have been developed which make it possible to achieve the desired concentration of fluoride with great and unvarying accuracy (Maier, 1950).

440. Some difference of opinion has been expressed as to the extent to which water supplies are being fluoridated overseas. We make some mention of this subject in Chapter 45. We are satisfied, however, that over 1,400 communities in the United States have fluoridated public water supplies, and there are other communities in the United Kingdom, Canada, and elsewhere which have adopted a similar process. These facts have enabled water-works engineers to assemble a great deal of information in regard to the efficiency of the equipment used and confirm that fluoridation can be carried out accurately to any desired level of concentration and with several different types of equipment.

441. Two principal types of equipment have been referred to. The first of these is a dry feeder capable of delivering a definite amount of the dry chemical to a solution tank. The second is a liquid feeder which delivers a solution containing the fluoride at a rate determined by the quantity of water to be fluoridated. Equipment of both types has been described to us and we have been referred to the available literature.

442. The dry feeders depend upon adding the proper quantity of the compound to the water, either by delivering a measured weight or a measured volume within a given period. They are equipped with solution tanks built in such a way that the flow of water through them ensures that the chemical is dissolved before it reaches the supply system. This type of equipment is suitable for large installations.

443. A solution or liquid feeder involves the pumping of the fluoride solution into the system at a rate automatically related to the flow of water. The solution itself is prepared to a known concentration, and that concentration is in turn diluted to the point at which the water contains the optimum level of fluoride. The experience at Hastings suggests that for smaller towns this type of feeder is more suitable than the dry feeder referred to above.

444. Mr Cameron gave evidence in Wellington on behalf of a large company which represents certain overseas manufacturers specialising in all branches of water treatment. He described several types of equipment which were available and which had been tested overseas (9V 4). He stated that "there is a range of equipment to cover all possible types of installations". He said "the feeding of fluorides is little different from the feeding of many other water-works chemicals. It simply calls for the correct equipment correctly applied".

445. Mr Mansergh, who is chief engineer of a company concerned with the purification of domestic water supplies in New Zealand, gave evidence in Auckland. He explained that some of the water undertakings in this country had features which might require special equipment before fluoridation could be undertaken, thereby increasing the cost of

installation. He concluded, however, by saying that if technical supervision was available there would be "no difficulty about the application of fluoridation to New Zealand conditions". (9H 2).

446. We have mentioned in paragraph 465 that the consulting engineer to the Riccarton Borough Council (Mr Sarjeant) had doubts about the corrosive effects of fluoride on water installations. Those views are not confirmed by any evidence and we are satisfied Mr Sarjeant has been handicapped by the fact that he has not acquainted himself with the reports of the working of fluoridation projects overseas. In relation to the present question as to whether fluoride could be added to water supplies with sufficient precision, he stated that overfeeding could take place. This evidence was directed particularly to problems associated with the Riccarton water supply. In the absence of sufficient information on the point we are unable to express any conclusion in regard to Riccarton. We think it unlikely that fluoridation is impracticable in that borough and that, as Mr Mansergh suggested in a general way, the cost of equipment would be the deciding factor there. We are satisfied, however, that any of the difficulties envisaged by Mr Sargeant have a very limited application.

447. The importance of delivering water containing the desired level of fluoride without fluctuations from time to time, or from place to place, does not require to be emphasised. But the general opinions of Mr Cameron and Mr Mansergh in regard to this, and to which we have referred, were confirmed by the qualified water-works engineers at Auckland, Christchurch, Wellington, and Lower Hutt, and also by Mr Fish, who has had some years of experience as the engineer in charge of the fluoridation plant at Hastings. He said (1H 1):

The present system for fluoridating the water supply is extremely satisfactory and I anticipate no difficulty whatever in maintaining a uniform and accurate level of 1 ppm throughout the whole of our reticulation.

448. Dr Longwell, who is principal scientific officer in the Department of the Government Chemist, United Kingdom, in charge of the division dealing with the examination and treatment of water, has said this (1955):

Those responsible for the supply of potable water in this country have very high standards, and the unquestioning acceptance by the general public of the water obtained by turning on their water taps, is a testimonial that has been well earned. The application of a steady dose of fluoride to the water is no more difficult than other additions of chemicals in general use, and it was found in America that even the smallest undertakings in the immediate control of an unqualified, sometimes spare-time attendant, were happily producing continuously a water fluoridated to the desired level.

He was a member of the United Kingdom Mission to the United States and joined in its report (1953) which states that:

... no evidence of overdosage was detected in an examination of the records of the nineteen water plants we visited in the United States. These plants ranged in size from that serving a population of 735 and maintained by the local handyman, to one under the control of a fully qualified staff which is supplying over 20 million gallons of water daily to 280,000 people.

449. We are satisfied that equipment is available to permit the addition of fluoride to public water supplies in this country with accuracy and safety. The choice of equipment, the nature of its installation, and its maintenance are all matters which would affect its efficiency however, and accordingly we are of the opinion that these matters too should be within the jurisdiction and control of a national body.

CHAPTER 50: TESTS AND CONTROL

450. To ensure that fluoridation units would be operated at all times with complete accuracy we consider that careful records should be kept, that appropriate tests should be made at regular intervals, and that the plant itself should be equipped with reliable automatic devices. We have been informed of several methods of achieving the desired accuracy of operation. In the following paragraphs we consider these matters in a general way.

451. At Hastings, as we have mentioned, a solution type feeder is in operation which passes the fluoride solution into the water supply by means of electrically operated pumps. These are calibrated against the water-works pumps to give the necessary uniform rate of discharge and they come into operation immediately the water-works pumps are put into operation. The solution itself is prepared in two tanks. A vulcanite union block and valve assembly fitted at the base of a pyrex glass tube and connected with the chemical pumps allows the pump to draw from either of the tanks while the gauge glass permits a quick and accurate visual check. The controls available at Hastings are:

- (1) By measurement when making up the solution.
- (2) By a specific gravity test after mixing in the solution tanks.
- (3) By means of the gauge glass in the pumphouse.
- (4) By sampling of the water itself after the solution has been added to it.

452. The efficiency of these various controls depends upon the use that is made of them. The Hastings practice is to keep daily records of the total quantity of the solution used, of the total output of water from the water-work's pumps, and of the result of tests made of this water itself. The analyses are carried out by the Dominion Laboratory and involve daily samples of the water. Periodically 4-hourly samples are tested.

453. Mr Johannesson described a conductivity supervision check which was based on the principle that the electrical conductivity of water is changed by the addition of ions such as the fluoride ion. He said (9T 2):

It will be seen from the analyses attached that the Kaitoke water has a total solids in solution of only 38 ppm. Addition of 2.2 ppm of sodium fluoride (= 1 ppm F) represents an increase of nearly 5.6 per cent. Actual measurements of conductivity on a tap sample gave as follows:

Tap water, 191 micromhos.

The same water, to which 1 ppm of fluoride has been added, that is to say 2.21 ppm of sodium fluoride, gave a value of 209 micromhos, that is, an increase of nearly 10 per cent.

Measurement of the conductivity difference between the raw and the treated water on an electrical recorder gives a measure of the addition of fluoride.

Mr Johannesson suggested that alarms could be fixed to indicate any deviation from the required limits. He referred us to a paper by Mr K. E. Knowlton (1955) in which the latter provided details of equipment which had been devised to make use of this principle and which had enabled direct control of the fluoridation equipment at North Beverly, U.S.A. Accurate records are automatically made on a continuous basis and the equipment had functioned satisfactorily for 18 months by the time the paper was written in February 1955.

454. The testing of the water itself, after the fluoride has been added, should be carried out at frequent and regular intervals and a proper record kept of the results. There are various standard tests used for the

analysis of the fluoride content of water. We consider, however, that it is unnecessary to discuss the details of those tests or to express our opinion as to the precise means by which the analyses should be carried out.

455. The importance of maintaining proper controls and tests in all these respects requires little emphasis. We are satisfied that there are adequate and efficient means of checking and testing the operation of fluoridation plants and we consider that those appropriate to each plant should be incorporated on installation. Decisions on these matters all require a consideration of many varying factors. We think that following the adoption of standard specifications a national body should be made responsible for the regulation and observance of the controls and tests it considers necessary in each individual case.

CHAPTER 51: METHODS OF HANDLING THE CHEMICAL AT PLANTS

456. No evidence was brought before us that the handling of the chemicals by water-works personnel would involve any hazard provided reasonable care was observed. We have stated in paragraph 214 that fluoride has no chronic toxic effects unless regular amounts are ingested at a level much above that recommended in the fluoridation proposals. The avoidance of those toxic levels by inhalation or otherwise is, of course, a matter of common sense and prudence.

457. Precautions to be taken by personnel handling the compounds have been considered in detail both in the United Kingdom Mission Report (1953) and by the American Waterworks Association (1949). It is recommended that the chemicals should be handled as little as possible, that respirators and goggles should be worn and devices should be available to keep the dust to a minimum.

458. Related to these questions is the method of storage to be adopted. The fluoride should be kept in a dry place and conveniently located in relation to the loading hopper or solution tank. In addition, we think it should be kept away from any unauthorised persons.

459. We are of the opinion that all these various matters can be dealt with satisfactorily and raise no serious problems. We recommend, however, that standards be defined in regard to them and the observance of those standards be within the jurisdiction of a national controlling body.

460. We have described in Chapter 21 that fluoride is rapidly eliminated from the body by the action of the kidneys. This fact makes it possible to check the fluoride intake by analysing the fluoride content of the urine. Such tests are carried out regularly at fluoridation plants to ensure that workmen are not inhaling the fluoride dust when handling the compound. We consider the practice a sensible precaution and recommend its adoption.

CHAPTER 52: EFFECTS ON WATER RETICULATION PIPES, INDUSTRIAL PLANT, AND INDUSTRIAL PROCESSES

461. Before leaving the question as to whether fluoridation can be carried out satisfactorily it is necessary to consider whether any problem arises in relation to the water reticulations themselves to industrial plants

and to industrial processes. Some suggestion was made before us that difficulties of this sort were involved, and so far as the evidence goes it is dealt with in the following paragraphs.

462. It was stated by several witnesses that the application of fluoride to the water supply would have a corrosive effect on the reticulation system and on plumbing. The matter was mentioned by Mr R. Sarjeant in Christchurch; it was referred to in a booklet prepared by Dr Eva Hill with the caption *Facts About Fluoridation of Water Supplies*; and in the pamphlet *Fluoridation the Poisoner* compiled by Madam Mira Louise to which reference has been made earlier in this report.

463. The reference in Dr Eva Hill's booklet, *Facts About Fluoridation of Water Supplies*, is as follows:

Fanchon Battelle reports that a number of cities that now fluoridate are experiencing breakdowns in their water systems and damage to plumbing throughout the community. Three water pumps in Northampton, Massachusetts, were destroyed, or nearly so, and many other towns including Newburgh, New York, reported the same difficulty. Citizens report water heaters destroyed, water pipes suddenly squirting water like a rotten rubber hose – you say fluorides are harmless? If they do this to cast iron and steel, what will they do to our bodies. What will be the cost to the citizens to replace or repair these mechanical items?

In regard to the statements contained in this extract we were informed by Dr C. N. D. Taylor, Medical Officer of Health, Palmerston North, New Zealand, that he had forwarded a copy to Mr F. M. Hennessy, Superintendent of the Northampton Water Department, and that in reply he had received a letter dated 15 April 1955 which he submitted for our consideration. It reads:

I was most interested in your inquiry of 7 April concerning reported breakdowns due to fluoridation in our city. This report originated, I believe, in a publication issued by an anti-fluoridation committee in this country and has been given wide publicity in the States, but I was quite surprised that it has such far-flung influence. This anti-fluoridation committee in its apparent zeal to defeat the fluoridation programme was either ignorant of the facts or extremely careless of the truth. In our brief experience with fluoridation, absolutely no damage was done to the water system or to plumbing. We did have some trouble due to the wearing of the propellers. This trouble developed during the time we were using sodium silico-fluoride. Our mixing chamber was so small that we were unable to get a complete dissolution of the silico-fluoride granules resulting in an abrasive action on the propellers as the solution went through the pumps. Rather than replace the mixing chamber with a larger one, we changed to sodium fluoride powder which is more soluble in water and we have experienced no further difficulties of any kind.

To the best of our knowledge no trouble has developed in any of our communities that are fluoridating their water supplies.

Sgd. F. M. HENNESSY,
Superintendent,
Northampton Water Department.

464. The booklet *Fluoridation the Poisoner*, compiled by Madam Mira Louise (James), also contains a statement relating to the effect of fluoride on water systems. It reads:

FLUORIDES DAMAGE WATER SYSTEM

Fluoridating cities are experiencing breakdowns in their water systems. Damage to plumbing is enormous. Detroit, Michigan, after once installing fluorine in its water supply stopped it because it corroded the pipes and water air conditioning units in the building beyond repair and the pipes and fittings had to be replaced. Citizens report heaters destroyed and corroded, pipes squirting water like a rotten rubber hose. And this is the corrosive chemical that is supposed to prevent tooth decay.

The health authorities at the above cities were also asked by Dr C. N. D. Taylor to comment on the statements made. The following are copies of the replies received by Dr Taylor and submitted with his evidence:

From C. P. Anderson, M.D.,
Deputy Health Commissioner,
Director of Medical Services, Detroit,
Dated 9.5.55.

The quote that you make regarding the breakdown of water systems where fluoridation is practised is absolutely without foundation. The city of Detroit has never gotten as far as installing fluoridation so could, of course, have had no adverse experience. The other communities in Michigan with which I am familiar have had no untoward problems in this regard in their water plants and absolutely no problems in the distribution system.

From David B. Ast, D.D.S.,
Director,
Bureau of Dental Health, Newburgh,
Dated 11.4.55.

I have your letter of 7 April and hasten to advise you that I know of no instance in which fluoridation of water supplies has in any way affected the equipment at the water-works plant, or the pipes through which the water is distributed to the community. Certainly there has been no such evidence in Newburgh for the past 10 years during which time the Newburgh water supply has been supplemented with sodium fluoride to bring its fluoride ion content up to 1.0 to 1.2 parts per million.

465. The only objecting witness to appear who claimed any knowledge on the subject of water supplies was Mr R. Sarjeant, consulting engineer to the Riccarton Borough Council. In his evidence he expressed concern at the possibility of "a long-term corrosive effect on metal parts of buried assets both publicly and privately owned". After explaining that his interest in engineering was principally in electrical engineering, he stated that he had reported to the Riccarton Borough Council recommending against fluoridation of the Riccarton borough water supply. In answer to Mr Woodhouse, however, he admitted that he had read none of the many technical publications on the subject of fluoridation of water supplies and that he was basing his opinion solely on his own general experience as engineer to the Riccarton Borough Council. He also stated before us that reports from reliable authorities, that fluoridation was working successfully, would not alter his opinion.

466. Evidence to the effect that there was no risk of harm to installations was given before us by several witnesses with an extensive knowledge and experience of public water supplies. Mr Fish, who has been in charge of the fluoridation plant at Hastings since it was first operated in 1953, informed us, for example (1H 1), that:

There has been no evidence of any corrosion of pipes or fittings in the reticulation system or in the underground chamber of the pumping station following fluoridation, which commenced in February 1953.

Mr Firth, who as we have mentioned is the city water-works engineer in Auckland, also discussed the matter of the effects of fluoride on water reticulations. He stated (4Z 1):

All the reports we have, and we have very many of them of course from the water-works people all over the world, show that at 1 ppm there is no effect on plumbing.

Mr A. H. Jecks, the city water-works engineer at Christchurch, stated (7Z 1) that he had never read that fluoridated water would have a corrosive effect, and Mr Johannesson in giving evidence on the same point said (9U 1):

I have perused the reputable scientific literature as has been available and find no reference to corrosion in water mains due to the presence of 1 ppm fluoride. . . . Sodium silico-fluoride at a concentration equivalent to 1 ppm fluoride is reputed to be dissociated into fluoride ions, sodium ions, and silicate ions. It might, therefore, be expected that a beneficial effect might be observed upon mains carrying water (fluoridated by means of the sodium silico-fluoride compound).

467. Very little evidence was made available to us in regard to the possible effects of fluoridation on industry, but Dr Eva Hill produced as an exhibit a copy of an address delivered by her in Hastings on 8 November 1955, in which she stated:

I will briefly refer to possible detrimental effects on industry. Cordial manufacturers will be faced with a dilemma, the fluoride interfering with their processing. Canning factories and freezing works in the district, even if not using your water supply, will be under suspicion throughout the country, and sales may fall in consequence. Fluorine has a definite affinity for certain metallic elements, difficulty may arise in dispensing certain medicants. This aspect has not yet been thoroughly investigated. Certain country visitors have already had to forgo their tea in restaurants.

In regard to this statement we think it is significant that no representative of industry appeared before us to support the views of Dr Hill. This is particularly relevant so far as Hastings is concerned since that town has now had a fluoridated supply for some years.

468. In considering this question Mr L. H. James, Assistant Director, Dominion Laboratory, Department of Scientific and Industrial Research, stated in his evidence given at Hastings (2L 1) that fluoride:

does not perceptibly alter the taste or smell of the water. It does not increase the hardness of the water, nor does it adversely affect the use of the water for commercial or manufacturing purposes.

The United Kingdom Mission to the United States in its report to its Government (1953) confirms the view expressed by Mr James. At paragraph 36 the members of the mission have said:

Effects on industry: Fluorides in water, at a level of 1.0 ppm, do not give a taste or odour and, in spite of persistent questioning, we have been unable to learn of an effect on any industry, including bottling, brewing, baking, laundering, and chemical manufacture. It was reported at Charlotte N.C. where the water supply is soft, that after fluoridation cracking of ice blocks increased by 50 per cent. This trouble was cured by the addition of 20 ppm of ammonium chloride to the water used for the manufacture of ice. It should be noted, however, that such difficulties have not been experienced at other places where similar fluoridated waters are used.

469. Our conclusions in regard to the foregoing matters are:

- (1) That the statements contained in the booklet by Dr Eva Hill and Madam Mira Louise (James), to which we have referred, are not in accord with the facts;
- (2) That Mr Sarjeant's conclusions are unsubstantiated by any evidence and might not have been arrived at by him if he had considered the available literature on the subject; and
- (3) That fluoridation is not a process which will have disadvantages to industry or in respect of water reticulations or plant.

CHAPTER 53: DEFLUORIDATION

470. In paragraph 239 reference is made to the occurrence of dental fluorosis in Bartlett, Texas, where the water supply contained 8 ppm of fluoride prior to the beginning of 1955. In that year a water-treatment process was introduced to lower the high natural fluoride concentration to the optimum level and thereby remove the risk of fluorosis. The

principle of the process is adsorption of the excess fluoride in a suitable chemical filter. This filtering process is working successfully and deals of course with the supply of the whole community.

471. Professor Shroff stated (6T 1) that the same principle can be applied to the water supply of a single household, by using treated bone (Smith, 1939) or synthetic apatite (Alder, Klein, & Lindsay, 1938) filters. This simple and effective means of removing fluoride from water could be used by people who prefer not to take fluoridated water. Professor H. V. Smith (Arizona), in a letter to Mr Woodhouse dated 13 March 1957, confirmed the efficacy of the household bone filter and stated that the purchase and cost of operating the filters is within range of the average American family. He said:

Home filters will remove part or all of the fluorine in the water, depending on the depth of media in the filter, upon the rate of water flow through the media, and the original content of the water being filtered. Filters need reactivation periodically, either by washing the media first with lye, then a weak acid, and finally with water. In some of the larger models, reactivation becomes necessary only after several months of use. If reactivation of the media seems impractical, the spent media may be discarded and replaced with fresh media.

In the United States very few home fluorine filters are in use because of the nuisance of caring for them. The purchase price and cost of operating the filters is within the range of the average family.

In Wellington, Mr Johannesson said (9V 1) that he had removed virtually all the fluoride in water. We consider an efficient filter could be produced in New Zealand if it were needed.

CHAPTER 54: CONCLUSIONS

472. We regard the following matters as established:

- (1) Several chemicals of a high standard of purity are manufactured for the fluoridation of public water supplies and these are entirely suitable for that purpose.
- (2) The process of fluoridation involves no new or unusual problems in water-works engineering.
- (3) Apparatus capable of mixing the fluoride in water supplies with precise and unvarying accuracy is readily available.
- (4) The process does not involve disadvantages to industry or in respect of water reticulations or plant.
- (5) Subject to the controls we recommend in paragraph 473 (which follows) the fluoridation of public water supplies can be carried out in New Zealand with accuracy and safety.

473. To avoid fluoridation projects developing in any haphazard way we recommend:

- (1) That standard specifications should be introduced dealing with all aspects of the treatment of water supplies with fluoride.
- (2) That a supervisory and controlling body should be set up on a national basis with authority to ensure that all proposed plants conform to the standards laid down.

Part VIII

ALTERNATIVE MEANS OF SUPPLYING FLUORIDE

CHAPTER 55: THE VEHICLES WHICH HAVE BEEN SUGGESTED

474. We have stated that in our view fluoride at the proper level of ingestion is beneficial to teeth and not harmful to health. Opponents of fluoridation of public water supplies have argued, however, that even if this were so a method should not be used of getting the fluoride to people who want or need it which cannot easily be avoided by those who do not. Various methods of making the substance available other than in water supplies have been suggested.

475. These witnesses have pointed out quite correctly that fluoridation of the water supply is wasteful of fluoride in that only a very small fraction of the domestic supply is used for drinking or cooking purposes; and they have suggested that fluoride might be dispensed in tablet form, with or without charge, for those who desire to use it. They have also pointed out the possible use of other food vehicles, to fluoride-containing tooth pastes and even to a chewing gum containing the substance.

476. Representative suggestions of alternatives are contained, for example, in the evidence of Mr Penlington, Mr Gamble, Mrs Hogg, Mrs Van Asch, Mr Moore, Mr Boulton, and Dr Eva Hill and in the submissions of Mr Jordan and Mr Dowling. The proposed alternatives were examined in turn by several supporters of fluoridation and they included Dr Davies, Mr Ludwig, Colonel Fuller, Dr Muriel Bell, Professor Gregory, Dr Taylor, Dr Roche, Mr Malthus, and Mrs Mulinder.

477. The merits of several methods of applying fluoride to the erupted teeth were discussed by Dr Davies. Direct application to the surface of the teeth of a strong fluoride solution (*topical application*) has been investigated extensively in several countries including New Zealand (Hewat & Rice, 1949). This process brings about 30 to 40 per cent reduction in dental decay, but he stated that it would not be feasible as a public health measure because it is too time consuming. The accepted method requires four applications at intervals of a week or less at the ages of 3, 7, 10, and 13 years. Each application takes about an hour. The period of time over which a beneficial effect is exerted is not known definitely and the method is not effective in adults.

478. He said that *fluoride-containing mouth washes* have not proved effective, and experiments with *dentifrices* containing sodium, potassium, or lead fluoride have given varying results (Bibby & Brudevold, 1954). A dentifrice containing stannous fluoride has been used by Muhler, Radike, Nebergall, & Day (1956) with promising results in a study of children aged 5 to 15 years. After one year dental decay had been reduced by 50 per cent, but the results are not conclusive.

479. The experiments with fluoride-containing dentifrices are also described in an exhibit (*Collier's Magazine*, 6 January 1956) submitted by Mr Penlington, a prominent opponent of fluoridation. From the fact

that stannous fluoride may be more effective for this purpose than, for example, sodium fluoride, he has inferred that the fluoride ion from the one source is different from the fluoride ion derived from the other. This, of course, is fallacious as we have stated in paragraph 162 (*supra*). The reason for any increased benefit in the case of stannous fluoride is due to the action of the tin component. The article brought to our notice by Mr Penlington appears to be the report of an interview with Dr Muhler, who is the leader of a group of investigators at the University of Indiana engaged in studying the beneficial effect of a stannous-fluoride-containing tooth paste. Dr Muhler is reported in the article as follows:

The tooth paste is no substitute for community water fluoridation. Dr Muhler has said: "That's the best decay prevention measure we know – the one way of making certain that all the kids in a town, rich and poor alike, are protected. But many communities are taking painfully long to fluoridate their water and 40 per cent of the population doesn't drink city water.

Dr Muhler confirms our own view that fluoridation is superior to the use of a stannous fluoride dentrifice as a public health measure.

480. The use of *food vehicles* for the application of fluoride was considered in the evidence of Mr Ludwig, Dr Muriel Bell, and Professor Elizabeth Gregory. They mentioned the following objections to the use of *milk* as an alternative vehicle:

- (1) If it were decided to add fluoride to milk instead of drinking water, there would be overwhelming problems in devising satisfactory technical methods of accurately incorporating the desired amount of fluoride in milk safely and effectively. This would be made more difficult because the fluoride would have to be added to relatively small quantities of milk.
- (2) Individual batches of milk would require to be tested and this could be done satisfactorily only under proper laboratory control. This would be quite impracticable.
- (3) Children of the same age vary greatly in their consumption of milk and, even if this were not so, it would be necessary to supply milk with several different concentrations of fluoride in order to supply children of different ages with the amount of fluoride they needed at that age.

481. These witnesses explained that varying concentrations of fluoride in water are not necessary to meet the requirements of children at different ages. In the case of milk the concentration would be at much higher level in parts per million than in fluoridated water. There would be the need to avoid giving infants, who normally subsist largely on milk, too much fluoride or older children (who drink less milk in proportion but need more fluoride) too little of the substance.

482. The requirements in regard to the use of milk would make for a very costly process and probably could not be overcome in practice. Added to these disadvantages is the absence of knowledge that fluoridation of milk would reduce the prevalence of dental decay.

483. The addition of fluoride to other vehicles like *bread* and *salt* raise technological difficulties which may not be difficult to surmount, but the consumption of these articles of diet was said to be so variable as to render them unsuitable.

484. *Fluoride tablets (sodium fluoride or calcium fluoride)*—Four of the witnesses who supported fluoridation, Dr Taylor, Mr Ludwig, Dr Newman, and Mr Malthus stated that they were supplying fluoride to their own children in the form of sodium fluoride tablets, and certain preliminary controlled studies by Held & Piquet (1954) in Switzerland and by Feltman (1951) in the United States are promising. But if fluoride tablets are to be effective the child must take them daily for at least the first 8 years of life, and the witnesses in stressing the need for regular dosage said that success depended greatly on the intelligence and perseverance of individual parents. Both fluoridated water and fluoride tablets have a similar effect on developing teeth, but the fluoride tablet is given in a single dose to ensure that the full daily quota is received. For this reason the more frequent topical effect of drinking fluoridated water is absent.

485. The supporters of fluoridation stated that the use of fluoride tablets is distinctly inferior to fluoridation and of unproven value as a public health measure, but they suggest that it is probably the best measure to offer to children living in districts which have no water reticulation. Dr F. S. Maclean and Dr H. B. Turbott informed us that the Department of Health considers that the question of providing fluoride for rural children needs further study.

486. A not unreasonable suggestion which originated with the Honourable H. G. R. Mason, Q.C., M.P., has recently reached us. It was suggested that addition of fluoride to the fertilisers which are spread widely on the soil in this country might be considered. The object of this would be to increase the fluoride content of foodstuffs grown in such soils. This is a matter which has been examined by several observers, including in New Zealand, Dr Marion F. Harrison and Dr Muriel Bell. They reported (1947), however, that when fluorine is present in the non-acid soils favourable for plant growth it is largely converted to the almost insoluble compound calcium fluoride. This is not available to the plant and, accordingly, food is a far less important source of fluoride than water. They referred also to the work of Smith, Smith, & Varich, quoted by Smith (1942), and said:

There is little or no evidence to support the view that food grown in fluoride-rich areas is richer in fluorine than that grown in fluoride-poor areas. Little difference was found in the fluorine content of food when sodium fluoride or calcium fluoride was added to the soil.

These opinions are accepted generally and we consider, therefore, that the addition of traces of fluoride to the soil would be ineffective.

487. In considering the various alternatives, Mr Ludwig, who is Dental Research Officer to the Medical Research Council of New Zealand, stated in evidence:

Use of alternative materials or "vehicles" as they are termed has been very carefully investigated by a special committee of the National Research Council of the United States, and this investigation was made particularly since a relatively large proportion of the population in the United States and in most other countries do not use a communal water supply, and consequently they may be denied the dental benefits resulting from water fluoridation.

The results of these investigations, or in particular the result of the investigation of the committee to which I have referred have shown clearly that for the present at least, and probably for a long time to come, water fluoridation represents the only known safe and effective method of administering fluoride that can be recommended for public health purposes.

The ideal vehicle should be of such a nature that it will be used consistently by the vast majority of the population and that the technical arrangements required in adding fluoride to it will be simple, inexpensive, and capable of rigid control.

It is known that the drinking water meets all of these requirements, but there is little or no evidence to show that such would be the case with any other dietary item.

488. We are satisfied that there are weighty objections to the use of fluoride tablets. These are:

- (i) There are no published studies on the use of tablets containing fluorides.
- (ii) The obvious difficulty with this method is that it is necessary for the parent to administer fluoride to each child each day and every day for the first 8 to 12 years of the child's life.
- (iii) The studies establishing the effectiveness of fluoride show that if the full protective effect of the fluoride is to be obtained the daily fluoride ration must be consumed in liquid form on a number of occasions. This adds substantially to a mother's domestic activities.
- (iv) While in individual instances the use of tablets may prove a feasible method, generally for families containing more than one child, it tends to be troublesome and spasmodic in application.
- (v) It is suggested that if these tablets are used the majority of people will cease using them in adolescence and any subsequent benefit arising from the topical effect of a fluoride on the teeth would be lost.

CHAPTER 56: CONCLUSIONS

489. We regard the following matters as established:

- (1) The food alternatives suggested are not practicable as vehicles for fluoride as they do not permit a low optimum concentration of the substance.
- (2) Humans naturally obtain the greater part of their dietary fluoride in water which is universally consumed.
- (3) Because the consumption of water is regulated by physiological need the ingestion of fluoride by this means is self limiting.
- (4) The efficacy of fluoridation as a public health measure is proven.
- (5) No alternative suggested to us would be effective as a public health measure.

490. For the foregoing reasons we are satisfied that there is no practicable method of adjusting the daily intake of fluoride other than by addition of that substance to public water supplies.

*Part IX***PERSONAL RIGHTS IN RELATION TO
FLUORIDATION****CHAPTER 57: THE NATURE OF THE ARGUMENT.**

491. Opponents of fluoridation have complained that the process necessarily involves forcing the fluoridated water upon them against their will. Because of this it is said that a serious threat to personal freedom is involved. This is an important issue and requires a rational answer. This can be given only if the claims themselves are defined and then are examined against the constitutional position in relation to them.

492. Before the various arguments can be properly evaluated a distinction should be drawn between two very different situations. In the first place there could be claims that an unsafe or ineffective process was about to be foisted on unwilling individuals. On the other hand claims might be made that it is wrong to introduce a beneficial and safe process unless there was unanimous acceptance of it. We think it likely that many of those who argued for their personal rights in this matter have really been influenced by anxiety lest the process of fluoridation be dangerous. In our opinion this feeling confuses the present issue and for the reasons we state in the following paragraphs.

493. We have already stated that fluoridation of public water supplies is effective in preventing dental decay and involves no risk to health or otherwise. We are satisfied also that the minute variation in the concentration of fluoride in the water which would be required would involve no substantial alteration in the character or quality of that water. If we had reached a contrary decision no further examination of the fluoridation proposal would be necessary. We assume that nobody would desire to implement a dangerous or an ineffective process. It appears to us, therefore, that unless the arguments raised in regard to personal rights are to be considered as an academic exercise and with no practical relevance they must be examined in the light of our findings that there is no danger; that the process is a valuable one; and that the benefits of fluoride can be made available in an effective way only by utilising public water services.

494. There is a need to remove any suggestion of risk from the present consideration of personal rights because, in our view, people would rightly resent something which could adversely affect them. Such a feeling, however, would not have any basis in their ideas of constitutional rights but in their natural reaction to a dangerous situation. We think it becomes easier to assess the degree of sympathy which should be accorded all these arguments if it is remembered that fluoridation is a safe and worth-while public health measure.

495. We turn to consider the arguments themselves in the following order:

- (1) The general claim concerns the constitutional position of the subject in relation to the State. In this connection we refer in Chapter 58 to the fundamental principle that the so-called liberties of the subject are not absolute rights but are subject to legal qualifications.
- (2) The particular claim refers to the rights of citizens in a public utility. We have explained in Chapter 59 that the broad personal freedoms which were discussed before us do not appear to be analogous in any sense to the rights of citizens in community water supplies.
- (3) It has been argued that compulsion is inherent in the fluoridation of water supplies. In Chapter 60 we state our opinion that, while the avoidance of fluoridated water may cause inconvenience, there is no requirement that every person should use that water and no other. Since it has been suggested that fluoridation is a type of "mass-medication" we have expressed our view in the same chapter that the process is not a process of medicating communities.

CHAPTER 58: THE LIBERTY OF THE SUBJECT

496. Many witnesses attempted to define before us their understanding of the rights they had as free citizens living in a democratic community. Mr Penlington expressed these feelings in the following way:

It is quite true that in a democracy the majority must rule, but there are certain matters in which the majority does not seek to impose its will on the minority – matters of conscience, for instance, and matters of diet, dress, medical treatment, and personal habits. The essence of democracy is not the domination of minority by majority, but rather the maintenance of a way of liberty by a mutual regard for personal freedom.

497. This feeling that the rights of individuals or minority groups would be infringed if fluoridation were adopted was emphasised in various ways. Mr McMillan (3P 3) said that it was compulsory mass-medication and, as such, a violation of the sanctity of personalities. Mrs Van Asch argued that public bodies should not become intolerant for reasons of expediency (3V 4). Mrs Stroobant described fluoridation as something un-Christian and un-British (4U 2). Mr Allen said (5L 4) that it was not sufficient to pay lip service to our British way of life and at the same time permit surreptitious attacks on it under the guise of a public good. Mr Moore stated that the process savoured of totalitarian methods (3W 1). In Dunedin, Miss Andrew said (7D 3) the "dosing of public water supplies is a means of forcing people irrespective of age or state of health . . . to consume a medicine": and in considering the same belief that the process was compulsory Mrs Van Asch said (3U 4):

This first threat to our freedom should be resisted with all our strength as a surrender at this time could be used to limit our freedom further in the future.

498. Mr Dowling appeared as counsel for the Anti-fluoridation Society at Hastings and made the following submission on behalf of his clients:

Water is an essential element in life, and must be consumed, so that the option in a pre-medicated public water supply does not exist for the individual to refuse, whether rightly or wrongly, to accept or undergo the treatment prescribed.

Those who make this submission recognise that the freedom of the individual to act as he or she chooses must be limited in the interest of the community as a whole, but we place that limitation on no higher level than to say that each individual while exercising his freedom of action must so conduct himself as not to interfere with a like liberty existing in other members of the community.

Those upon whose behalf these submissions are made feel that we must at all costs defend the freedom of the individual citizen from the arbitrary action of the State and preserve his right to accept or reject for himself whether he will submit to medication against his will while he remains in a condition of mind to exercise a free choice.

It will be observed that Mr Dowling has recognised that some qualification must be made to the freedom of action enjoyed by individuals. In the following paragraphs we consider the extent and nature of those qualifications.

499. A general outline of the constitutional position is contained in the following extract from *Halsbury's Laws of England*, Third Edition, Volume 7, paragraph 416, page 195:

416. The so-called liberties of the subject are really implications drawn from the two principles that the subject may say or do what he pleases, provided he does not transgress the substantive law, or infringe the legal rights of others, whereas public authorities (including the Crown) may do nothing but what they are authorised to do by some rule of common law or statute. Where public authorities are not authorised to interfere with the subject, he has liberties. It follows that apart from the general provisions ensuring the peaceful enjoyment of rights of property, and the freedom of the subject from illegal detention, duress, punishment, or taxation, contained in the four great charters or statutes which regulate the relations between the Crown and people, the liberties of the subject are not expressly defined in any law or code. Further, since Parliament is sovereign the subject cannot possess guaranteed rights such as are guaranteed to the citizen by many foreign constitutions. It is well understood that certain liberties are highly prized by the people, and that in consequence Parliament is unlikely, except in emergencies, to pass legislation constituting a serious interference with them.

500. In the foregoing extract it is stated that the subject does not possess guaranteed rights. Because Parliament is the supreme law-making authority the Courts cannot control its decisions, and in this connection it is, of course, the view of the majority which prevails. Professor C. C. Aikman, Professor of Jurisprudence and Constitutional Law at Victoria University College, Wellington, gave evidence before the Commission and has rendered material assistance to it on the constitutional issues involved in the matter of the freedom of the subject. In regard to these questions he said (10F 2):

A decision on a particular matter whether at the national level or at the municipal level will reflect the views of the majority rather than those of a minority or of a single individual. The wise majority will take care that the minority has a full opportunity of expressing its views before a decision is taken and will provide adequate procedures for ensuring that the rights of the minority are subjected to no more interference than is the necessary result of the decision. However, in the modern social service state, as we know and accept it, the majority feels called upon to take more and more decisions in fields in which there was formerly no necessity for legislative interference. It is conceded on all sides that under modern conditions the Government – and I include local bodies – must take a greater responsibility for the social and economic welfare of the community than did 19th century Governments. This trend has narrowed the meaning of liberty of action for the individual. Thus, in the field of public health, as medical knowledge has increased, we are provided with more and more instances in which private convenience and individual freedom of action has had to yield to the public good.

501. It is the case that in certain overseas countries the liberty of the subject is expressly defined in the Constitution. In the United States of America the powers of Congress, of the State Parliaments, and of

municipal bodies are all subject to the "Bill of Rights" which forms part of the United States Constitution. The American Courts, therefore, have jurisdiction to review legislation whether it be at Federal, State, or municipal level in order to determine whether it conflicts with the fundamental freedoms protected by the Constitution.

502. In that country the Courts of ten States have held that the fluoridation of public water supplies is a valid exercise of power by the authority concerned. On the only occasion that an adverse opinion was delivered that opinion was reversed on appeal. We are informed that the statutes and constitutions interpreted by those Courts include what is described as "police power". This expression has a much wider concept than would be expected from our own use of the word "police". That it is a wide power is shown by the Charter of the City of Shreveport in Louisiana. This charter confers upon the city powers "which in the opinion of the Council, are necessary or desirable to promote the general welfare of the city and the safety, health, peace, good order, comfort, convenience, and morals of its inhabitants".

It appears that the two main contentions by opponents of fluoridation as disclosed in the United States decisions have been:

(1) The fluoridation of a public water supply compels people to take a form of medication contrary to their religious beliefs in contravention of the First Amendment to the Constitution of the United States; and

(2) The fluoridation of a public water supply deprives a person of his right as part of his personal liberty to protect his health as he deems best. This it is said is in contravention of the Fourteenth Amendment to the United States Constitution.

In each instance in which those arguments were advanced they were dismissed by the State Courts concerned; it was held that the fluoridation of public water supplies did not involve infringement of constitutional liberties.

503. Although no representations were made to us on religious grounds or by any religious organisation as such we think it desirable to refer to the attitude of United States Courts to arguments that have been raised in that country on this ground. The Supreme Court for San Diego county, for example, in the case of *de Aryan v. Butler* (No. 169974 - decided 3 April 1952) said:

Religious freedom embraces two concepts; freedom of *belief* and freedom to *act*. The first is absolute, but in the nature of things the second cannot be, in that all acts or conduct of our citizens must conform to all reasonable regulations adopted by the respective governmental agencies acting within the scope of their authority.

In an appeal from this decision the District Court of Appeal included the following statement in its decision:

The United States Supreme Court, in establishing and clarifying the constitutional rights of religious and other freedoms, has distinguished between the direct compulsions imposed upon individuals, with penalties for violations, and those which are indirect or reasonably incidental to a furnished service or facility. (*de Aryan v. Butler* 260, p. 2D 98.)

504. The other main contention before the United States Courts has been based on the Fourteenth Amendment of the Constitution. In this regard the view of the Supreme Court of Louisiana is as follows (*Chapman v. Shreveport* (No. 41717 - decided 31 May 1954):

The Fourteenth Amendment does not deprive a state or its divisions of the right to preserve order or to protect the health of the people under its police power, and in the exercise of its power the legislative branch may interfere with

and impair the individual liberty of the citizens in a manner and to an extent reasonably necessary for the public interest, and the Courts will not interfere except where the measures invade fundamental rights or are arbitrary, oppressive, or unreasonable. This is not a proper case for judicial interference.

505. The Supreme Court of Ohio was also obliged to consider the question of liberty in relation to fluoridation of water supplies (*Kraus v. Cleveland* (1954) 121 NE2d311). In the course of their judgment the Judges of this Court relied upon the words of Justice Harlan, a well known Judge of the Supreme Court Bench of the United States, in an earlier case dealing with a claim that a man had an inherent "right to care for his own body and health in such a way as seems to him best". (*Jacobsen v. Massachusetts* 197 U.S. 11 (1905)). There are several passages in this judgment which are relevant to the present inquiry. At page 26, Justice Harlan said:

Liberty . . . does not import an absolute right in each person to be, at all times and in all circumstances, wholly freed from restraint. There are manifold restraints to which every person is necessarily subject for the common good. On any other basis organised society could not exist with safety to its members. Society based on the rule that each one is a law unto himself would soon be confronted with disorder and anarchy. Real liberty for all could not exist under the operation of a principle which recognises the right of each individual person to use his own, whether in respect of his person or his property, regardless of the injury that may be done to others.

In a subsequent passage (pages 37 to 38) Justice Harlan speaking for a majority of the Judges of the Supreme Court of the United States stated:

We are not prepared to hold that a minority residing or remaining in any city or town where smallpox is prevalent, and enjoying the general protection afforded by an organised local government, may thus defy the will of its constituted authorities, acting in good faith for all, under the legislative sanction of the State. If such be the privilege of a minority then a like privilege would belong to each individual of the community, and the spectacle would be presented of the welfare and safety of an entire population being subordinated to the notions of a single individual who chooses to remain a part of that population. We are unwilling to hold it to be an element of the liberty secured by the Constitution of the United States that one person, or a minority of persons, residing in any community and enjoying the benefit of its local government, should have the power thus to dominate the majority when supported in their action by the authority of the State.

506. The principles enunciated by the Courts of the United States are founded in the Constitution of that country. We consider, however, that they are entirely in accord with the general concept of liberty in New Zealand. It was submitted by Mr Woodhouse that freedom in democratic countries meant liberty *subject to law* and this necessarily must be so. The claim made by Mr Penlington to which we refer in paragraph 496 that the majority in a democracy does not seek to impose its will on the minority in matters of conscience, diet, dress, medical treatment, and personal habits appears to us to be subject to many qualifications. The criminal code is a striking instance of this, but there are numerous other examples of interference by the State in such matters as the quality of food offered for sale, decency of dress, standards of medical treatment, the education of children, and the right to work in certain occupations.

507. It is our opinion, therefore, that citizens of democratic States cannot properly claim that their liberty of action is absolute. Their proper claim, we think, is that it should not be arbitrarily interfered with. It appears to us that this distinction has not been appreciated by many witnesses who have appeared to oppose fluoridation.

CHAPTER 59: THE RIGHTS OF CITIZENS IN PUBLIC UTILITIES

508. Apart from arguments based on broad questions of constitutional freedom we have been obliged to consider the particular claims of witnesses in relation to public water services. Miss Andrew defined this issue when she said at Dunedin (7D 2):

Each individual has the natural right to expect and to obtain pure water from his community water supply.

509. There are numerous communities in this country which have no public water supply. If a small group of residents in such a community invited its neighbours to install a community supply but was then out-voted, nobody could argue that the rights of the minority were being roughly handled because it was deprived of the service it wanted. Moreover, most local bodies which do have water supplies have enacted bylaws enabling the supply to be regulated. It seems to us that persons receiving some water through a community service, whether the water is fluoridated or not, cannot be in a worse position than those who receive none at all.

510. Individuals possess an obvious right to water as one of the essentials of life. We do not consider, however, that they have an equivalent right to receive it through a man-made system or, given the system, to receive it without interruption, in unlimited quantities, and according to a specification which suits their individual tastes.

CHAPTER 60: THE QUESTION OF COMPULSION

511. It has been claimed on many occasions during this inquiry that there is no option available to those who, for varying reasons might wish to avoid fluoridated water. Associated with this argument is the complaint that the fluoridation of a community supply amounts to "compulsory mass-medication". In our view this objection cannot be sustained on any logical ground.

512. We have described in paragraph 228 our conclusion that fluoride is not a drug or a medicine and the reasons which have persuaded us to that conclusion. We are satisfied also that the process of fluoridation involves no substantial alteration in the nature or quality of water, but results in a minute variation being made in the concentration of a substance already present in it. We have considered in two ways, therefore, the belief that fluoridation is a type of medication. In the first place we have examined the way in which fluoride exerts a beneficial influence on the human body. In this regard we are satisfied that the substance is a nutrient and not a medicine, and accordingly fluoridation is not a form of medication. In the second place, we have considered the practical effect of the process in relation to natural waters and we are confirmed in the opinion we have expressed by reason of the fact that the character of the water, in a material sense, remains unchanged.

513. Altogether apart from the view expressed in the preceding paragraph we regard as conclusive the fact that the process *compels* nobody to drink fluoridated water. People do not have to use community water supplies and, indeed, in the Hastings district we were informed that certain residents there were avoiding the local supply. By avoiding a

community supply people may be inconvenienced in a greater or lesser degree, but there is, of course, a vast difference between being compelled in some respect and being disturbed or inconvenienced about it.

514. Some witnesses have suggested that in all areas in this country rainwater is available to those who might wish to avoid the public water supply. They have pointed to the fact that at the present time many citizens obtain water from this source because they do not have access to a reticulated system. It was argued, too, that if individuals regard the question as an important point of principle then they should be prepared to seek unfluoridated water elsewhere rather than impose their preference on a whole community.

515. As we have stated in Chapter 53, there are efficient home filters which are able to remove the fluoride from water. We consider that if it seemed desirable or necessary, such filters could be made available in this country, and in that event an additional means of avoiding fluoridated water would be available to those who wished to do so. Whether those who oppose fluoridation would be satisfied with an alternative is another question. For example, we were informed that in Christchurch there are approximately 3,000 to 4,000 private wells. One of these is available to Mrs Crowley, who gave evidence in that city. She stated, however, that this alternative was not satisfactory. The following extract from her evidence (8J 4) deals with the question of choice:

Are you more concerned with that (the freedom question) than the safety aspect? . . . Definitely—with the freedom, because I think people ultimately come to realise whether it is safe or not.

And if it were proved safe you would still feel people should have a choice? . . . Absolutely.

That is your position? . . . Absolutely.

And if they did have a choice—that is to say, if they could avoid taking fluoridated water—you would be satisfied? . . . No, I don't think I would. I think the water should be left alone—by man, because it is a pure beautiful thing. . . .”

516. In Dunedin, Miss Andrew claimed “the right to contract out of any situation or condition which in his or her view appears to affect his or her personal interest”. (7D 2). This is a general claim which obviously could not be supported in its present sweeping form. She then dealt with the particular subject of fluoridation and said (7D 3):

There is only one right way to approach such a controversial subject. Those who believe in and want fluoridation for themselves or their children should be able to have access to fluoridated water, or fluorine pills, or take it in whatever form they desire. If there is a real demand, a supply will readily be forthcoming for those who want it. On the other hand, those who do not want fluoridated water must be able to abstain from such medication, as is the case with any kind of medication, vaccination, drugs, etc.

Mr Woodhouse addressed certain questions to her arising out of the views she had expressed and the relevant extract is as follows (7D 5):

You suggested I think, that problem here was that individuals should have the right to contract out of any situation? . . . Yes.

Let us imagine that became possible in this process. Let us imagine that you as an individual could contract out of this, would you then object to the rest of the community getting it if they wanted it? . . . I would say that is putting the cart before the horse. At the present moment we have pure water. You are getting, really, away from my point.

I know the point that you are trying to make, but I maintain it is irrelevant. If it is possible to contract out of this, you have no objection to other people getting it if they want it? . . . I think people have the right at the present time to pure water which should not be taken away, and that comes before this question of contracting out.

517. Like Mrs Crowley and Miss Andrew other witnesses who had claimed that fluoridation was compulsory were not prepared to withdraw their objection on this ground even when an opportunity "of contracting out" was suggested to them. It may be that these witnesses felt that they had a duty to crusade in the matter on behalf of other sections of the community.

518. We are satisfied, therefore, that there is no compulsion about fluoridation in the sense that people have no option. We think that in some cases there may be a degree of personal inconvenience involved in avoiding the public water supply, but this is far from the invasion of personal rights which were discussed before us by many witnesses. It seems to us, also, that the convenience of individuals in a matter such as this should be weighed against that of the rest of the community when considering what decision should be made.

519. It is inherent in the views we have expressed on this aspect of the matter that the opinions of any minority should be carefully considered. If this is done that minority cannot, of course, claim it has been arbitrarily dealt with. On the other hand, it is certain that minorities cannot expect to dictate to the majority. Nor can decisions be avoided merely because there is disagreement. It is said in a joint statement issued by the Hastings and Havelock North Borough Councils that "if the rights of a minority to object are to prevail then in a matter like this the minority completely prevents the great majority from enjoying their rights". Decisions are rarely made unanimously, and when Mr McCombs was asked if he agreed that the views of the people who might be in a minority should be respected in these matters he said - "Quite. But at the same time the views of the majority demand more respect". We think that Mr McCombs, who, as an ex-Minister of the Crown could claim to speak with some authority on those questions, was putting in a sentence the essence of democratic government.

520. We consider, therefore, that in such a matter as this objectors to any proposal may rightly claim to be heard before any determination is made. This is in accord with constitutional principle and with natural justice. But in this democratic community and on such a subject the will of the majority should then prevail.

CHAPTER 61: CONCLUSIONS

521. Concerning all the foregoing matters it is our conclusion:

- (1) That the avoidance of fluoridated water might cause inconvenience but in no case would its use be compulsory;
- (2) That the process does not involve medication of community supplies;
- (3) That humans have an inherent right to water as one of the essentials of life but not such wide interests in regard to community water supplies which are merely one of the means of providing it; and

(4) That no question of personal liberty arises in regard to fluoridation.

522. In stating these conclusions we repeat the view we have expressed in paragraphs 493 and 494 that the issue concerning rights of individuals has practical importance only after a decision is made:

- (1) That fluoridation is a desirable process;
- (2) That the benefits of fluoride cannot effectively be made available by alternative means; and
- (3) That it is completely safe.

This process would be unacceptable if it were ineffective or hazardous. We are satisfied, therefore, that any objections based on these general principles should be evaluated as objections to a public health measure which is not only beneficial but which is safe.

*Part X***THE POSITION OF LOCAL AUTHORITIES****CHAPTER 62: THE INTRODUCTION AND CONTROL OF FLUORIDATION IN NEW ZEALAND**

523. In the words of Dr P. P. Lynch, President of the New Zealand Branch of the British Medical Association, we are satisfied that in New Zealand "fluoridation could be adopted with great benefit and without danger to the community" (9H 2). We are equally satisfied that those citizens who might wish to avoid fluoridated water could be left with a choice in that respect. It is our recommendation, therefore, that the process be used extensively for the purpose of reducing the widespread incidence of dental decay. If this recommendation is to be acted upon, questions arise as to:

- (1) The level at which a decision should be made to fluoridate a public water supply;
- (2) The process to be followed in reaching such a decision; and
- (3) Whether or not the Government should take any steps in regard to the matter.

These questions are raised directly by the third and fifth inquiries addressed to us in the terms of reference.

524. In Part IX of this report we have considered the various arguments that fluoridation might deprive certain individuals of their democratic rights. In paragraph 519 we express the opinion that minorities cannot expect to dictate to majorities in a matter such as this. But we have added that decisions should not be made until a reasonable opportunity is given for considering the varying opinions that might be held on the subject.

525. We have referred in paragraph 500 to the views of Professor C. C. Aikman in this regard. Professor C. L. Bailey, Professor of Education at Victoria University College, Wellington, also appeared before us in order to describe his own attitude to these principles. He said (10A 4):

I believe it to be right and proper for a society to legislate to make it legally possible to secure a generally more effective form of treatment for children, provided that in the discussions leading to the legislation the public has been consulted and given the fullest opportunity of expressing its views. . . .

With regard to fluoridation I am satisfied that the steps being taken to consult the public interest satisfy the democratic criterion and thereby do not hurt the principle of civic liberty. . . .

The liberty of the individual consists not in preventing what the majority wishes, but in enjoying the right and the liberty of attempting to convince the majority that it is wrong.

With these expressions of opinion we are in complete agreement.

526. During the inquiry reference was made to the fact that on occasions communities had been invited to make a decision in regard to fluoridation by the method of referendum. The subject of fluoridation is, however, a complex and highly technical one and many aspects of it are difficult to explain. Moreover, a referendum inevitably means that

the will of the majority prevails and occasionally on inadequate information. The method was criticised before us by witnesses on both sides of the general argument. We are of the opinion that it is an unsatisfactory method of arriving at a decision on such a matter as the fluoridation of public water supplies.

527. When the suggestion was made that the Hastings water supply should be fluoridated an announcement to that effect appeared in the local newspapers (see para. 378), and subsequently there were a number of council meetings and a good deal of public discussion. For these reasons it is the position that the subject was brought before public notice on several occasions. In addition, the council did not act without seeking the advice and approval of the Department of Health. Since the plant was installed the Fluoridation Committee of the Department of Health has continued to render valuable assistance to the Hastings Corporation. We think, however, that steps should be taken to ensure that in every case where there is a proposal to fluoridate a public water supply the public has reasonable opportunity of considering the matter and also that the plant is established and operated under the direction and control of a national authority.

528. In considering the means by which decisions should be made to fluoridate public water supplies, we are influenced by the general principles outlined in the foregoing sub-paragraphs. It is our opinion, therefore, and we recommend:

- (1) That decisions in regard to the fluoridation of public water supplies should be permitted at the local government level. It appears to us that this is properly a matter for decision by individual communities and one which should be examined and decided by each local authority as the effective voice of the community it represents.
- (2) That a procedure analogous to the special order procedure outlined in section 77 of the Municipal Corporations Act 1954 be mandatory in all cases of local authorities proposing to introduce fluoridation. As this involves a special meeting, public notification of the resolution and a subsequent meeting of confirmation individual citizens would be given proper opportunity of expressing their views and making appropriate representations.
- (3) That a national fluoridation authority be established with powers to approve, supervise, and control the establishment, operation, and maintenance of all fluoridation plants throughout the country. This recommendation is also contained in Part VII of this report where reference is made in addition to the need for regulations fixing national standards in various respects.

CHAPTER 63: THE RELEVANT LEGISLATION

529. The existing and relevant powers of local authorities in regard to public health are contained in the Municipal Corporations Act 1954 and in the Health Act 1920. By section 288 of the first of those Acts, councils: may do all things necessary from time to time for the preservation of the public health and convenience and for carrying into effect the provisions of the Health Act 1920 so far as they apply to the district.

Section 20 of the Health Act is concerned with the general powers and duties of local authorities in respect of public health and so far as it is applicable that section reads as follows:

Subject to the provisions of this Act it shall be the *duty* of every local authority to promote and conserve the public health within its district . . . (The italics are ours.)

One of the functions of the Department of Health is the duty of advising: local authorities in matters relating to public health in so far as those local authorities are charged with the care of the public health by this or any other Act (section 12 (b) of the Health Act 1920).

530. The powers of local authorities in regard to the supply of water are contained in the same Acts. Section 240 of the Municipal Corporations Act permits the construction and maintenance of waterworks "for the supply of pure water" while section 36 of the Health Act requires dwellinghouses to be provided with "wholesome water". The addition of any pollutant is forbidden for obvious reasons, and this is defined in section 2 of the Municipal Corporations Act as:

any substance that contaminates the water so as to change the physical or chemical contents thereof in such a manner as to make the water unclean, noxious, or impure, or so as to be detrimental to the health safety or welfare of persons using the water.

We are quite satisfied that the fluoride compounds proposed to be added to water supplies do not come within the definition.

531. Questions as to the meaning of the expressions "wholesome water" and "pure water" arose in the course of the inquiry. In this regard we are of the opinion that the expression "pure water" cannot possibly refer to chemically pure water which does not occur in nature and cannot be produced artificially except with difficulty. Nobody would wish to receive such water through community services even if it were feasible to provide it. Accordingly, we consider the expressions "pure" and "wholesome", as used in the Acts, refer to water that is agreeable to taste, smell, and appearance, and is suitable for human consumption. Seventy years ago the highest legal tribunal in England held that water remained pure and wholesome despite the fact that it contained small quantities of sulphuric acid which could not be harmful to health. (*Milnes v. Huddersfield Corporation* (1886) 11 Appeal Cases 511, 528). We are of the opinion that the addition of beneficent quantities of fluoride to water would add, if anything, to its wholesomeness and could not detract from its purity.

532. Mr L. R. Franks (9K 2) invited us to consider the effect of section 4 of the Food and Drugs Act 1947. In that Act the word "food" includes "drinking water". The relevant portion of the section reads:

For the purposes of this Act, any food or drug shall be deemed to be adulterated:

- (a) If it contains or is mixed or diluted with any substance which diminishes in any manner its nutritive or other beneficial properties as compared with the food or drug in a pure and normal state and in an undeteriorated and sound condition, or which in any other manner operates or may operate to the prejudice or disadvantage of the purchaser or other consumer.

Mr Franks stated that there are persons who believe that fluoride will act to their disadvantage. He argued that for this reason at least it could not legally be added to water supplies. We have already stated that in proper quantities fluoride is a nutrient (para. 228), and we are satisfied that the process of fluoridation, properly administered, will act distinctly to the advantage of the community.

533. Other witnesses argued that local authorities in New Zealand would be acting outside their statutory powers if they added fluoride to public water supplies. In this connection we were referred to certain decisions of Canadian Courts holding that in some provinces there was no power to fluoridate public water supplies. It appears to us, however, that these decisions are founded in the domestic legislation to which they relate, just as contrary decisions of the United States Courts (mentioned by us in Chapter 59) interpret similar local legislation. Questions of this nature are entirely questions of law and are properly answered by the Courts. We think it appropriate, therefore, merely to indicate our opinion that the fluoridation of public water supplies by local authorities in New Zealand would not be outside their statutory powers provided it were effected by adequate processes.

CHAPTER 64: CONCLUSIONS

534. In regard to the foregoing matters our conclusions and recommendations are as follows:

- (1) A decision to fluoridate public water supplies should be left to the communities concerned.
- (2) A referendum or local body poll is an unsatisfactory method of reaching a decision on a technical and complex question such as fluoridation.
- (3) Local authorities are established for the purpose of making community decisions and should be permitted to decide whether or not public water supplies should be fluoridated.
- (4) The powers of local authorities in regard to the taking of decisions to fluoridate public water supplies, and also in regard to the implementing of such decisions, should be limited to the extent indicated in the following subparagraphs.
- (5) The special order procedure described in section 77 of the Municipal Corporations Act 1954 should be followed by all local authorities proposing to fluoridate public water supplies.
- (6) A national body should be established charged with the duty of encouraging, advising, and assisting local authorities in regard to the installation and maintenance of fluoridation plants. It should have authority to require compliance with appropriate and uniform standards, and those standards should be laid down by the Government.

535. Introduced in accord with the foregoing principles we are satisfied that widespread use should be made of the fluoridation process for the purpose of achieving an urgently needed improvement in the present serious state of dental health in New Zealand.

Part XI

SUMMARY OF CONCLUSIONS

(A) THE VALUE OF FLUORIDATION

536. *The Dental Health Problem in New Zealand*—(1) Virtually every child born in New Zealand experiences dental decay and, in consequence, an unduly high proportion of the population over the age of 21 years uses some form of denture.

(2) Sustained efforts over many years by both the Department of Health and the dental profession to introduce improved dietary habits have been ineffective. At the present time there is no hope of any programme of dental health education achieving a significant beneficial effect.

(3) The problem of controlling the rate of dental decay is beyond the resources of the dental services in this country.

(4) The filling of teeth is not a preventive measure, but merely a means of treating decay.

(5) The incidence of dental decay in New Zealand is so widespread and severe that it constitutes a major problem in public health and is a matter for grave concern.

537. *The Relation of Fluoride to Dental Health*—(1) Fluoride is a natural component of all teeth and by hardening their mineral structure it makes them more resistant to dissolution by acids.

(2) In New Zealand the fluoride content of potable waters is considerably below 1 ppm.

(3) In areas where there is fluoride in drinking waters at optimum concentrations, whether naturally present or artificially added, the prevalence of dental decay in children is at least 50 per cent lower than in areas where the fluoride content is 0·2 ppm or less. In the higher fluoride areas about one-third of all children escape dental decay entirely and the beneficial effects continue into adult life.

(4) There is no evidence that the consumption of fluoridated water would do harm to the pulp of the teeth or to the tissues which surround and support them.

(5) The regular ingestion of a substantial excess of fluoride (more than 1·9 ppm) in the drinking water may cause dental fluorosis. This is only one type of mottled enamel. Other enamel defects unrelated to fluoride are common. Enamel defects can develop only during the years of childhood.

(6) When the drinking water contains 1 ppm fluoride, or slightly more, the incidence of dental fluorosis has no significance.

(7) As the result of painstaking and thorough scientific observations conducted over a period of at least 40 years, there is a rational basis for the proposal to add fluoride to public water supplies in which this trace element may be deficient.

538. *The Value of Fluoridation in New Zealand*—The fluoridation of public water supplies in New Zealand would be followed by substantial benefits to dental health.

(B) THE BEHAVIOUR OF FLUORIDE IN THE BODY

539. *The Nature of Fluorine*—(1) The element fluorine does not occur in a free state in nature and has no relevance to the fluoridation process.

(2) The process is aimed at increasing the concentration of fluoride ions in water supplies, and those ions do not possess the properties of fluorine in its free elementary state.

(3) Excepting radioactive fluoride, which is not relevant, all fluoride ions are alike and, irrespective of their source, do exactly the same things in both a chemical and a biochemical sense.

(4) Organic compounds of fluorine are extremely stable and do not dissociate to give fluoride ions in aqueous solution.

(5) No distinction can be drawn between the fluoride naturally in water and the fluoride proposed to be added to it by the fluoridation process.

540. *The Ingestion of Fluoride*—(1) Fluoride is a normal constituent of human diet and, in fact, no diet is completely devoid of this element.

(2) The principal source of fluoride is water in all normal circumstances.

(3) Fluoride is a normal constituent of the bony structure of the body and of teeth.

(4) It is absorbed easily but, since most of the fluoride absorbed is readily excreted by the kidney, and the residue deposited in bones, it does not accumulate in soft tissues or impair the activity of enzyme systems.

(5) Storage in the bones is a reversible process, although it is likely that some retention occurs at all levels of intake.

541. *The Toxicity of Fluoride*—(1) Fluoride is beneficial in proper amounts and the optimum level in drinking water can be established with certainty.

(2) In common with all foods, including pure water, it can become harmful in substantial excess.

(3) Acute poisoning could be produced only by such a great excess that the possibility becomes irrelevant in relation to the fluoridation of water.

(4) In the proposal to fluoridate water there is no risk of chronic fluoride poisoning.

(5) The suggestion that fluoride is an enzyme poison has no relevance to fluoridated water.

(6) The implication contained in certain anti-fluoridation literature that fluoridation involves the use of a substance with properties similar to certain deadly organic compounds of fluorine is absurd and entirely misleading.

(C) THE MEDICAL QUESTIONS

542. Fluoridated water does not cause or aggravate any of the following disorders:

(1) Disorders of the brain and nervous system, disorders of the special senses, and disorders of the mind.

(2) Disorders of the heart and blood vessels.

(3) Disorders of the kidney and urinary tract.

- (4) Cancer.
- (5) Diabetes or disorders of the thyroid gland.
- (6) Disorders of the gastro-intestinal tract and the liver.
- (7) Disorders of pregnancy and labour or developmental defects in children.
- (8) Disorders of bones, joints, and the bone marrow.
- (9) Irritation of the eyes or irritation of mucous membranes.

543. *The Spira-Waldbott Syndrome*—The signs and symptoms of the alleged syndrome may be due to any number of unrecognised causes and there is no causal relationship between any of these signs and symptoms, and the ingestion of water containing 1 ppm of fluorine and food cooked in this water.

544. *General Conclusions Concerning the Relation of Fluoride to Health*—(1) The process of fluoridation does not add a substance that is foreign to the water but merely brings about a slight change in the concentration of the fluoride already present naturally in that water.

(2) No diet is devoid of fluoride, and water is the normal vehicle for conveying this substance to the body.

(3) Fluoride is a normal constituent of bones and teeth.

(4) Fluoride is a nutrient and is beneficial in proper amounts. In common with many other foodstuffs it has adverse effects on the body when ingested in excess.

(5) In the proposal to fluoridate public water supplies there is no risk of excessive ingestion; there is no risk of chronic fluoride poisoning; and the possibility of acute poisoning can be disregarded entirely.

(6) No harmful effects on health will follow the fluoridation of water supplies whether in respect of the complaints specifically made before us or otherwise.

(D) MECHANICAL CONSIDERATIONS

545. (1) Several chemicals of a high standard of purity are manufactured for the fluoridation of public water supplies and these are entirely suitable for that purpose.

(2) The process of fluoridation involves no new or unusual problems in waterworks engineering.

(3) Apparatus capable of mixing the fluoride in water supplies with precise and unvarying accuracy is readily available.

(4) The process does not involve disadvantages to industry or in respect of water reticulations, or plant.

(5) Subject to the controls recommended in sub-paragraph (6) (which follows) the fluoridation of public water supplies can be carried out in New Zealand with accuracy and safety.

(6) To avoid fluoridation projects developing in any haphazard way it is recommended that:

- (a) Standard specifications should be introduced dealing with all aspects of the treatment of water supplies with fluoride.
- (b) A supervisory and controlling body should be set up on a national basis with authority to ensure that all proposed plants conform to the standards laid down.

(E) THE LACK OF ALTERNATIVES TO FLUORIDATION OF WATER SUPPLIES

546. (1) The food alternatives suggested are not practicable as vehicles for fluoride as they do not permit a low optimum concentration of the substance.

(2) Humans naturally obtain the greater part of their dietary fluoride in water which is universally consumed.

(3) Because the consumption of water is regulated by physiological need the ingestion of fluoride by this means is self-limiting.

(4) The efficacy of fluoridation as a public health measure is proven.

(5) No alternative suggested would be effective as a public health measure.

(6) There is no practicable method of adjusting the daily intake of fluoride other than by addition of that substance to public water supplies.

(F) PERSONAL RIGHTS

547. It is our opinion that:

(1) The avoidance of fluoridated water might cause inconvenience, but in no case would its use be compulsory.

(2) The process does not involve medication of community supplies.

(3) Humans have an inherent right to water as one of the essentials of life; but no such wide interests in regard to community water supplies which are merely one of the means of providing it.

(4) No question of personal liberty arises in regard to fluoridation.

(5) As the process would not be acceptable if it were ineffective or hazardous, any objections to it based on personal right should be evaluated as objections to a public health measure which is not merely beneficial but also safe.

(G) THE POSITION OF LOCAL AUTHORITIES

548. It is our opinion that:

(1) A decision to fluoridate public water supplies should be left to the communities concerned.

(2) A referendum or local body poll is an unsatisfactory method of reaching a decision on a technical and complex question such as fluoridation.

(3) Local authorities are established for the purpose of making community decisions and should be permitted to decide whether or not public water supplies should be fluoridated.

(4) The powers of local authorities in regard to the taking of decisions to fluoridate public water supplies, and also in regard to the implementing of such decisions, should be limited to the extent indicated in the following subparagraphs.

(5) The special order procedure described in section 77 of the Municipal Corporations Act 1954 should be followed by all local authorities proposing to fluoridate public water supplies.

- (6) A national body should be established charged with the duty of encouraging, advising, and assisting local authorities in regard to the installation and maintenance of fluoridation plants. It should have authority to require compliance with appropriate and uniform standards, and those standards should be laid down by the Government.

(H) GENERAL FINDING

549. Introduced in accord with the principles outlined in paragraph 548 we are satisfied that widespread use should be made of the fluoridation process for the purpose of achieving an urgently needed improvement in the present serious state of dental health in New Zealand.

Part XII

**SPECIFIC FINDINGS IN TERMS OF WARRANT
OF APPOINTMENT**

The matters into which we are specifically directed to inquire with the conclusions reached by us thereon are as follows:

(1) Whether benefits to dental health may reasonably be expected in New Zealand from the addition of fluoride to public water supplies, having regard to the results of the fluoridation of water supplies in other countries:

Conclusion: **YES.**

(2) Whether any disadvantages may result from the addition of fluoride to waters naturally containing less than one part of fluoride per million:

Conclusion: **NO.**

(3) Whether it is desirable or expedient that local authorities should be permitted to decide on such addition for the benefit of residents, particularly children, of their districts:

Conclusion: **It is our opinion that local authorities are established for the purpose of making community decisions and should be permitted to decide whether or not public water supplies should be fluoridated, subject however to the limitations indicated in the conclusions mentioned in paragraph (5) hereof.**

(4) Whether there are any practicable methods of adjusting the daily intake of fluoride other than by addition to the water consumed.

Conclusion:

- (i) **There is no practicable method of adjusting the intake of fluoride other than by addition of that substance to public water supplies.**
- (ii) **No alternative suggested would be effective as a public health measure.**

(5) Whether, and to what extent, the Government should take any steps in relation to the powers or actions of local authorities in respect of any of the foregoing matters.

Conclusion: **It is our opinion that:**

- (i) **The special order procedure described in section 77 of the Municipal Corporations Act 1954 should be followed by all local authorities proposing to fluoridate public water supplies.**
- (ii) **A national body should be established charged with the duty of encouraging, advising, and assisting local authorities in regard to the installation and maintenance of fluoridation plants. It should have authority to require compliance with appropriate and uniform standards and those standards should be laid down by the Government.**

As we are directed to inquire into and report upon such other questions coming to our notice as we consider should be investigated we have heard and considered submissions relating to the impact of fluoridation on personal rights. This aspect is fully covered in this report and we repeat the conclusions already recorded herein, namely that:

- (a) The avoidance of fluoridated water might cause inconvenience but in no case would its use be compulsory.
- (b) The process does not involve medication of community supplies.
- (c) Humans have an inherent right to water as one of the essentials of life; but not such wide interests in regard to community water supplies which are merely one of the means of providing it.
- (d) No question of personal liberty arises in regard to fluoridation.
- (e) As the process would not be acceptable if it were ineffective or hazardous any objections to it based on personal right should be evaluated as objections to a public health measure which is not merely beneficial but also safe.

GENERAL CONCLUSIONS

Introduced in accordance with the principles outlined in paragraph 548 we are satisfied that widespread use should be made of the fluoridation process for the purpose of achieving an urgently needed improvement in the present serious state of dental health in New Zealand.

The above conclusions appear in greater detail within Part XI hereof, paragraphs 536 to 549 inclusive.

Appendices

APPENDIX A

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APPENDIX B

TABLE 1: Percentage of New Zealand Children With One or More Decayed Deciduous Teeth

Age Last Birthday (Years)	Number of Children Examined	Percentage of Children With One or More d e f Teeth	S.E. of Percentage
2	431	46	2.4
3	565	68	1.96
4	389	85	1.81
5	692	88	1.24
6	570	91	1.19
7	515	94	1.05
8 and 9	414	96	0.96

S.E. = Standard error.

From HEWAT, R. E. T., EASTCOTT, D. F. & BIBBY, J. B. (1952). The Prevalence of Dental Caries in Deciduous Teeth of N.Z. Children. *New Zealand Dental Journal*. 48, 160.

TABLE 2: Percentage of New Zealand Children With One or More Decayed Permanent Teeth

Age Last Birthday (Years)	Number of Children Examined	Percentage of Children With One or More D M F Teeth	S.E. of Percentage
7	503	69.4	2.05
8	534	90.8	1.28
9	515	95.0	0.96
10	521	98.3	0.57
11	544	98.7	0.48
12	523	99.4	0.34
13	480	99.4	0.35
14	452	99.5	0.33

From FULTON, J. T. (1951). Experiment in Dental Care. Results of New Zealand's Use of School Dental Nurses. Monograph Series No. 4. World Health Organisation. Geneva.

TABLE 3: The Dental Decay Problem in New Zealand Based on the Results of Clinical Examinations

Age Last Birthday (Years)	d e f Teeth			D M F Teeth		
	Number of Children Examined	Mean Per Child	S.E. of Mean	Number of Children Examined	Mean Per Child	S.E. of Mean
2	431	2.25	0.18	..	..	..
3	565	4.2	0.19	..	..	..
4	389	6.7	0.26	..	..	..
5	692	7.1	0.17	..	..	..
6	570	7.37	0.18	..	..	..
7	515	7.89	0.16	503	2.01	0.07
8	534	5.31	..	534	3.09	0.06
9	515	4.80	..	515	3.82	0.06
10	521	3.50	..	521	4.44	0.07
11	544	1.80	..	544	5.62	0.10
12	523	0.59	..	523	7.08	0.14
13	480	0.24	..	480	8.87	0.16
14	452	0.11	..	452	10.01	0.17

Sources: The data for children aged 2 to 8-9 years were obtained from HEWAT, R. E. T., EASTCOTT, D. F. & BIBBY, J. B. (1952). *Loc. cit.* The data for children aged 8 to 14 years were obtained from FULTON, J. T. (1951). *Loc. cit.*

TABLE 4: Dental Decay in the Permanent Teeth of New Zealand Children: Results of Combined Clinical and Radiographic Examinations

Age Last Birthday (Years)	Number of Children Examined	Mean D M F Teeth Per Child	Age Last Birthday (Years)	Number of Children Examined	Mean D M F Teeth Per Child
7	44	3.82	13	411	14.10
8	48	3.92	14	581	16.53
9	55	4.85	15	427	17.46
10	48	6.75	16	325	18.61
11 and 12	237	9.41			

From HEWAT, R. E. T. (1948). Field Studies on Dental Caries in New Zealand. *New Zealand Dental Journal*. 44, 163.

TABLE 5: Dental Decay in Compulsory Military Training Recruits

Age in Years	Number of Recruits Examined	Mean Number of Teeth Per Recruit			
		Decayed	Missing	Filled	D M F
18	244	5.9	5.6	5.7	17.2
19	154	6.6	6.1	5.7	18.4
20	58	6.1	6.6	5.9	18.6
21	141	4.4	10.4	5.6	20.4
Total sample	597	5.7	7.0	5.7	18.4

From DAVIES, G. N. (1953). Studies on Dental Caries in New Zealand II. Dental Caries Experience and Treatment Requirements of Compulsory Military Training Recruits. *New Zealand Dental Journal*. 49, 92.

TABLE 6: Dental Decay in Pregnant Women Attending Queen Mary Ante-natal Clinic in Dunedin

Age Group (Years)	Number of Women With Teeth Present	Mean Number of Teeth Per Person			
		Decayed	Missing	Filled	D M F
16-20	31	7.3	6.8	5.8	19.9
21-25	100	4.8	11.9	5.2	21.9
26-30	53	2.9	12.4	7.4	22.7
31-35	23	2.5	12.7	7.4	22.6
36-40	9	2.4	20.0	2.1	24.5
	216	4.4	11.7	5.9	22.0

From LITTLEJOHN, C. M. (1953). Unpublished data.

TABLE 7: Extent to Which the Population in New Zealand is Receiving Dental Treatment by the National Dental Service

Year Ended 31 March.	Age Group (Years)	Estimated Population (to Nearest Thousand)	Under Treatment by School Dental Nurses		Under Treatment by Dental Officers Attached to Adolescent Dental Clinics		Under Treatment by Dentists in the Private Practitioner Service		Approximate Number (to Nearest Thousand) Under Treatment Privately or Not Receiving Treatment	
			Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
1955	2 and under 5	150,000	44,976	30	12,528	3	163,494	37	105,000	70
	5 and under 16	438,000	215,556	49					46,000	11
		588,000	260,542	44	12,528	2	163,494	28	151,000	26

Sources—(1) Estimates of population have been made by interpolation of figures in the *New Zealand Official Year-Book* for 1956. They are approximations only.

(2) The numbers of children receiving dental treatment by the National Dental Service have been taken from the *School Dental Service Gazette* of November 1955.

TABLE 8: Fluoride Concentrations (ppm) in Successive Layers of Enamel from Areas With 0.1, 1.0, and 5.0 ppm Fluoride in the Water Supply

Layer of Enamel	Deciduous Enamel	Permanent Enamel					
	From Area With 0.1 ppm F in Water	Aged Less Than 20 Years From Areas With 0.1 ppm F in Water		Aged Less Than 20 Years From Area With 5.0 ppm F in Water	Aged Over 50 Years From Area With 0.1 ppm F in Water		Aged Over 50 Years From Area With 1.0 ppm F in Water
		Chicago	Chicago	Buffalo	Post (Texas)	Buffalo	Chicago	McKinney (Texas)
Outermost 1 ..	240	460	499	3,370	971	1,080	1,552
2 ..	129	114	162	1,710	512	540	727
3 ..	55	93	108	1,124	320	305	328
4 ..	54	..	63	926	297	190	227
5 ..	49	51	76	811	194	198	219
Innermost 6 ..	50	..	42	570	150	114	158

From ISSAAC, S. (1956). A Study of Fluoride in Enamel: Its Relation to Fluoride in Drinking Water and to its Rate of Dissolution in Acid. M.S. Thesis. University of Rochester.

TABLE 9: Reduction in the Prevalence of Dental Decay in Deciduous Teeth After Ten Years' Fluoridation at Grand Rapids

Age Last Birthday (Years)	Average Number of Decayed, Extracted, and Filled Deciduous Teeth Per 100 Children at:				Reductions at Grand Rapids (1954) Compared With:	
	Grand Rapids, 1954	Grand Rapids, 1944	Muskegon, 1954 ¹	Aurora, 1945 ²	Grand Rapids, 1944	Muskegon, 1954 ¹
4	212	419	303	207	Per Cent 49.4	Per Cent 30.0
5	250	537	398	279	53.4	37.2
6	295	643	485	336	54.1	39.2
7	326	629	535	351	48.2	39.1
8	331	578	498	360	42.7	33.5
9	300	459	381	298	34.6	21.2
10	235	284	275	228	17.2	14.5
11	132	135	142	118	2.2	7.0
12	44	47	61	43	6.4	27.9

¹Fluoride content of the Muskegon water supply adjusted from 0.2 ppm to 1 ppm in 1951.

²Natural fluoride content of Aurora water supply is 1.2 ppm.

From ARNOLD, F. A., DEAN, H. T., JAY, P. & KNUTSON, J. W. (1956). Effect of Fluoridated Water Supplies on Dental Caries Prevalence. Public Health Reports 71, 652.

TABLE 10: Reduction in the Prevalence of Dental Decay in Permanent Teeth After Ten Years' Fluoridation at Grand Rapids

Age Last Birthday (Years)	Average Number of Decayed, Missing, and Filled Permanent Teeth Per 100 Children at:				Reduction at Grand Rapids (1954) Compared With:	
	Grand Rapids, 1954	Aurora, 1945	Grand Rapids, 1944	Muskegon, 1954	Grand Rapids, 1944	Muskegon, 1954
6	19	28	78	45	Per Cent 76·6	Per Cent 57·8
7	69	71	189	114	63·5	39·5
8	127	104	295	218	56·9	41·7
9	197	152	390	316	49·5	37·6
10	234	202	492	372	52·4	37·1
11	298	267	641	458	53·5	34·9
12	387	295	807	612	52·0	36·8
13	505	309	973	798	48·1	36·7
14	678	364	1,095	1,074	38·1	36·9
15	807	454	1,248	1,119	35·3	27·9
16	995	519	1,350	1,255	26·3	20·7

From ARNOLD, F. A., DEAN, H. T., JAY, P. & KNUTSON, J. W. (1956). *Loc. cit.*

TABLE 11: Reduction in the Prevalence of Dental Decay in Deciduous Teeth After Ten Years' Fluoridation at Brantford, Canada

Age Group (Years)	Average Number of Decayed and Filled Deciduous Teeth Per Child at:				Reduction at Brantford (1955) Compared With:	
	Brantford, 1955	Stratford, 1955 ¹	Sarnia, 1955 ²	Brantford, 1948	Brantford, 1948	Sarnia, 1955 ²
6-8	2·93 ± 0·121	2·60 ± 0·113	5·09 ± 0·130	4·95 ± 0·134	Per Cent 40·8	Per Cent 42·4
9-11	1·99 ± 0·094	1·65 ± 0·094	2·31 ± 0·102	2·37 ± 0·101	16·0	13·8

¹Stratford water supply contains 1·6 ppm natural fluoride.

²Sarnia water supply contains no fluoride.

Brantford water supply was fluoridated on 20 June 1945.

In this table the mean number of decayed and filled deciduous teeth per child is given together with the standard error of the mean.

From BROWN, H. K. (1955). Dental Effects of Water Fluoridation. 1955 Report. Department of National Health and Welfare, Ottawa.

TABLE 12: Reduction in the Prevalence of Dental Decay in Permanent Teeth After Ten Years' Fluoridation at Brantford, Canada

Age Group (Years)	Average Number of D M F Teeth Per Child at:				Reduction at Brantford (1955) Compared With:	
	Brantford, 1955	Stratford, 1955	Sarnia, 1955	Brantford, 1948	Brantford, 1948	Sarnia, 1955
6-8	0.69±0.052	0.67±0.051	1.88±0.072	1.41±0.064	Per Cent 51.8	Per Cent 63.3
9-11	2.28±0.083	1.89±0.084	4.44±0.103	4.07±0.093	43.9	48.6
12-14	4.84±0.137	3.77±0.156	8.42±0.196	7.68±0.164	36.9	42.5

In this table the mean number of teeth per child is given together with the standard error of the mean.

From BROWN, H. K. (1955). *Loc. cit.*

TABLE 13: Reduction in the Prevalence of Dental Decay in Permanent Teeth After Ten Years' Fluoridation at Newburgh

Age (Years)	Average Number of Decayed, Missing, and Filled Permanent Teeth Per 100 Children at:		Reduction at Newburgh (1955) Compared With:
	Newburgh, 1955	Kingston, 1955 ¹	Kingston, 1955 ¹
6-9	98	234	Per Cent 57.9
10-12	328	699	53.0
13-14	610	1,170	47.9
16	975	1,649	40.9

¹Kingston water supply contains no fluoride.

From AST, D. B., SMITH, D. J., WACHS, B. & CANTWELL, K. T. (1956). Newburgh-Kingston Caries-Fluorine Study XIV. Combined Clinical and Roentgenographic Dental Findings after Ten Years of Fluoride Experience. *Journal American Dental Association*, 52, 314.

TABLE 14: Dental Decay in Deciduous Teeth of Children Living at Newburgh and Kingston, May 1956

Age Group (Years)	City		Number of Children Examined	Mean d e f Teeth Per Child	Difference	S.E. of Difference	<i>p</i>
6-9	Kingston	..	34	5.47	1.66	0.74	0.05
	Newburgh	..	37	3.81			
10-12	Kingston	..	22	2.64	0.50	0.59	N.S.
	Newburgh	..	21	2.14			

Newburgh water supply was fluoridated on 2 May 1945.

From DAVIES, G. N. (1957). An independent Assessment of the Results of the Newburgh-Kingston Fluoridation Study. *New Zealand Dental Journal*. 53, 17.

TABLE 15: Dental Decay in Permanent Teeth of Children Living at Newburgh and Kingston, May 1956

Age Group (Years)	City		Number of Children Examined	Mean D M F Teeth Per Child	Difference	S.E. of Difference	<i>p</i>
6-9	Kingston	..	34	2.85	1.17	0.41	0.05
	Newburgh	..	37	1.68			
10-12	Kingston	..	33	6.00	2.88	0.64	0.01
	Newburgh	..	32	3.12			

From DAVIES, G. N. (1957). *Loc. cit.*

TABLE 16: Fluoride Content of Public Water Supplies in New Zealand

Locality	Fluoride (ppm)	Locality	Fluoride (ppm)
Kaitaia	0.20	Stratford	0.25
Kawakawa	0.20	Papatoetoe	0.55
Kaikohe	0.15	Thames	0.20
Rawene	0.30	Paeroa	0.10
Dargaville	0.25	Waihi	0.15
Whangarei	0.10	Te Aroha	0.20
Helensville	0.25	Huntly	0.45
Auckland—		Hamilton	0.25
City	0.30	Te Puke	0.15
Onehunga	0.50	Morrinsville	0.20
One Tree Hill	0.15	Matamata	0.10
Otahuhu (1944-2 samples)	0.25	Tauranga	0.10
Mangere	0.30	Cambridge	0.20
Pukekohe	0.20	Te Awamutu	0.10
Rotorua	0.20	Otorohanga	0.10
Whakatane	0.15	Te Kuiti	0.10
Opotiki	0.20	Taumarunui	0.25
Gisborne	0.05	Eketahuna	0.10
Wairoa	0.05	Masterton	0.05
Waitara	0.15	Carterton	0.10
New Plymouth	0.05	Greytown	0.10
Martinborough	0.15	Paraparaumu	0.10
Featherston	0.10	Lawrence	0.10
Upper Hutt	0.10	Alexandra	0.25
Lower Hutt	0.05	Petone	0.10
Hawera	0.05	Wellington	0.10
Manaia	0.05	Picton	0.10
Raetihi	0.20	Blenheim	0.10
Taihape	0.05	Nelson	0.10
Napier	0.15	Brightwater Wells	0.15
¹ Hastings and Havelock North	0.13	Westport	0.15
Waipawa	0.10	Reefton	0.15
Waipukurau	0.05	Greymouth	0.10
Patea	0.20	Hokitika	0.10
Waverley	0.10	Kaikoura	0.15
Wanganui	0.05	Kaiapoi	0.15
Marton	0.05	Rangiora	0.15
Feilding	0.10	Christchurch	0.15
Dannevirke	0.10	Lincoln	0.10
Woodville	0.10	Leeston	0.10
Palmerston North: Artesian	0.10	Southbridge	0.15
Tiritea	0.10	Lyttelton	0.15
Foxton	0.20	Methven	0.10
Shannon	0.25	Ashburton	0.10
Levin	0.05	Temuka	0.10
Otaki	0.10	Geraldine	0.10
Pahiatua	0.10	Pleasant Point	0.15
Timaru	0.15	Cromwell	0.10
Fairlie	0.10	Queenstown	0.15
Waimate	0.15	Mosgiel	0.15
Oamaru	0.15	Milton	0.15
Palmerston	0.15	Tapanui	0.25
Dunedin	0.15	Balclutha	0.10
Port Chalmers	0.15	Gore	0.15
Inglewood	0.10	Invercargill	0.30

¹Prior to fluoridation.

See CHAMBERLAIN, G. (1944). *New Zealand Journal of Science and Technology*. 26B, 90.
 CHAMBERLAIN, G. (1946). *Ibid.* 28B, 1954.
 DENMEAD, C. F. (1946). *Ibid.* 28B, 158.

TABLE 17: Prevalence of Dental Decay in New Zealand Compared With That in Three Fluoridation Areas in the United States and Canada: Results of Clinical Examinations

Age Last Birthday (Years)	New Zealand ¹	Grand Rapids - Muskegon		Brantford, 1944	Age Group (Years)	New Zealand ¹	Kingston 1954-55 ³	Brantford, 1948 ⁴	Sarnia, 1948 ⁴	Sarnia, 1955 ⁴
		Grand Rapids ²	Muskegon ²							
		Mean D M F per person					Mean D M F per person			
7	2.01	1.89	1.99	1.87	9-11	4.6	4.07	4.21	4.44	4.44
8	3.09	2.95	2.81	2.40	10-12	5.71	5.42	..	..	..
9	3.82	3.90	3.81	3.87	..	8.6	..	..	..	..
10	4.44	4.92	4.91	3.71	12-14	9.42	8.78	7.94	8.84	8.84
11	5.62	6.41	6.32	4.60	13-14	..	..	..	..	..
12	7.08	8.07	8.66	6.41	..	..	..	..	..	..
13	8.87	9.73	9.98	7.61	..	..	..	..	..	..
14	10.01	10.95	12.00	8.75	..	..	..	..	..	..

From ¹FULTON, J. T. (1951). *Loc. cit.*

²ARNOLD, F. A., DEAN, H. T., JAY, P. & CANTWELL, K. T. (1956). *Loc. cit.*

³AST, D. B., SMITH, D. J., WACHS, B. & CANTWELL, K. T. (1956). *Loc. cit.*

⁴BROWN, H. K. (1955). *Loc. cit.*

TABLE 18: Comparison of the Mean D M F Permanent Teeth Per Child in New Zealand and Brantford, Sarnia, and Stratford in Canada: Results of Clinical Examination

Age (Years)	New Zealand		Sarnia, 1955		Brantford, 1955			Stratford, 1955				
	Number of Children Examined	Mean D M F Teeth Per Child	S.E.	Number Examined	Mean	S.E.	Number Examined	Mean	S.E.	Number Examined	Mean	S.E.
6-9	1,037	2.57	0.05	571	1.88	0.072	508	0.69	0.052	541	0.67	0.051
7-8	1,580	4.64	0.05	573	4.44	0.103	522	2.20	0.083	485	1.89	0.084
9-11	1,455	8.58	0.09	485	8.42	0.196	523	4.84	0.137	434	3.77	0.156

S.E. = Standard error of the mean.

From FULTON, J. T. (1951). *Loc. cit.*
 BROWN, H. K. (1955). *Loc. cit.*

TABLE 19: The Prevalence of Dental Caries in New Zealand Compared With That in the Newburgh-Kingston Fluoridation Area: Results Based on Combined Clinical and Radiographic Examinations

Age Group (Years)	New Zealand		Newburgh (After 10 Years' Fluoridation), 1954-55		Kingston (Control City), 1954-55	
	Number of Children Examined	Mean D M F Teeth Per Child	Number of Children Examined	Mean D M F Teeth Per Child	Number of Children Examined	Mean D M F Teeth Per Child
6-9	..	..	708	0.98	913	2.34
7-9	147	4.24	..	..	..	..
10-12	285	8.96	521	3.28	640	6.99
13-14	992	15.52	263	6.10	441	11.70
16	325	18.61	109	9.75	119	16.49

From HEWAT, R. E. T. (1948). *Loc. cit.*

AST, D. B., SMITH, D. J., WACHS, B. & CANTWELL, K. T. (1956). *Loc. cit.*

TABLE 20: Number of Teeth Affected by Dental Decay Per 100 Teeth Erupted at Hastings (New Zealand) and Kingston (New York)

Age (Years)	Number of Teeth Affected by Decay Per 100 Teeth Erupted	
	Hastings Before Fluoridation	Kingston (Not Fluoridated)
6-9	29.8	23
10-12	34.6	32
13-14	53.3	43
16	63	58

LUDWIG, T. G. (1956). Unpublished data.

TABLE 21: The Prevalence of Dental Fluorosis and Idiopathic Enamel Defects in Fluoride and Non-fluoride Areas in England

Location	Fluoride Content of Water in ppm	Number of Children Examined	Percentage of Children With:					
			Idiopathic Enamel Defects	Dental Fluorosis				
				Questionable	Very Mild	Mild	Moderate	Severe
West Mersea	5.8	51	4	16	12	2	25	31
Burnham-on-Crouch	3.5	62	3	10	29	16	26	11
Harwich ..	2.0	92	16	22	32	4	8	..
Slough ..	0.9	119	31	10	6	2	1	..
Saffron Walden	0.1	145	30	..	..	..	..	..
Surrey Schools	0.1-0.2	114	30	..	..	..	..	..

From FORREST, JEAN R. (1956). Caries Incidence and Enamel Defects in Areas with Different Levels of Fluoride in the Drinking Water. *British Dental Journal*, 100, 195.

TABLE 22: The Prevalence of Dental Fluorosis and Idiopathic Enamel Defects in Newburgh and Kingston

Examiner	City	Number of Children Examined	Percentage of Children With:					
			Idiopathic Enamel Defects	Dental Fluorosis				
				Questionable	Very Mild	Mild	Moderate	
Davies ..	Newburgh ¹ ..	70	11.4	18.6	4.3	1.4	..	
	Kingston ..	70	21.4	..	1.4	..	..
Russell	Newburgh ¹ ..	438	8.2	10.5	5.9	1.4	..	
	Kingston ..	612	18.9	0.6	..	..	..

¹Newburgh water supply was fluoridated on 2 May 1945. Kingston water supply contains no fluoride.

From DAVIES, G. N. (1957). *Loc. cit.* and RUSSELL, A. L., cited by AST, D. B., SMITH, D. J., WACHS, B. & CANTWELL, K. T. (1956). *Loc. cit.*

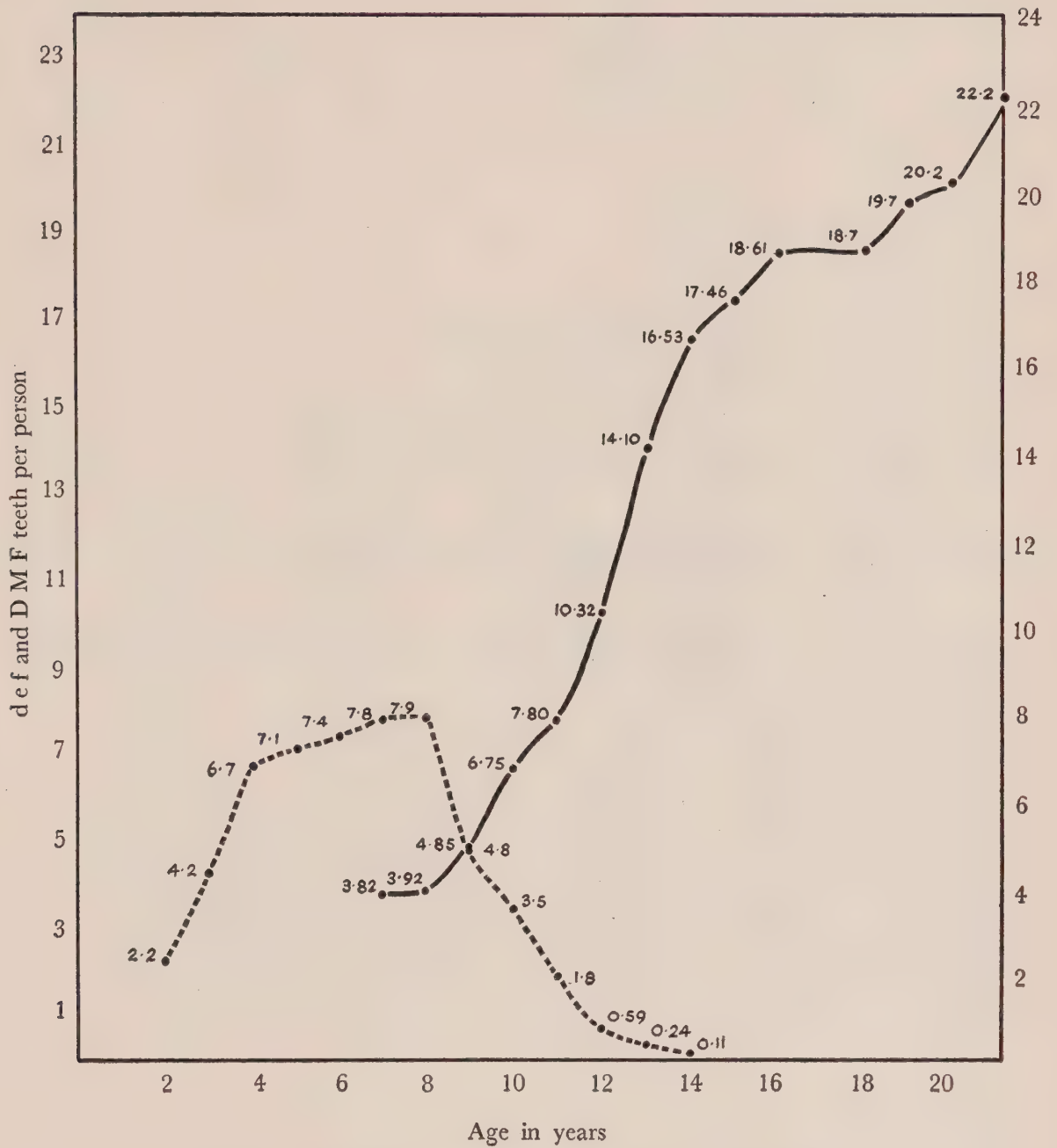


Fig. 1: Prevalence of dental caries in New Zealand.

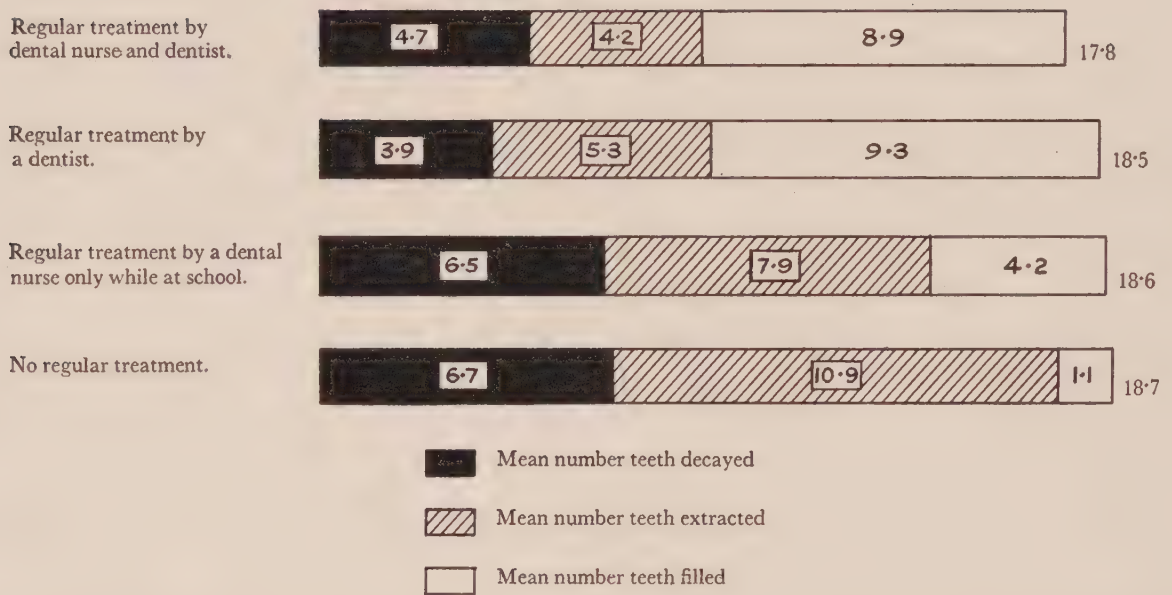


Fig. 2: Previous treatment and dental caries experience among New Zealand military training recruits (18-21 years of age).

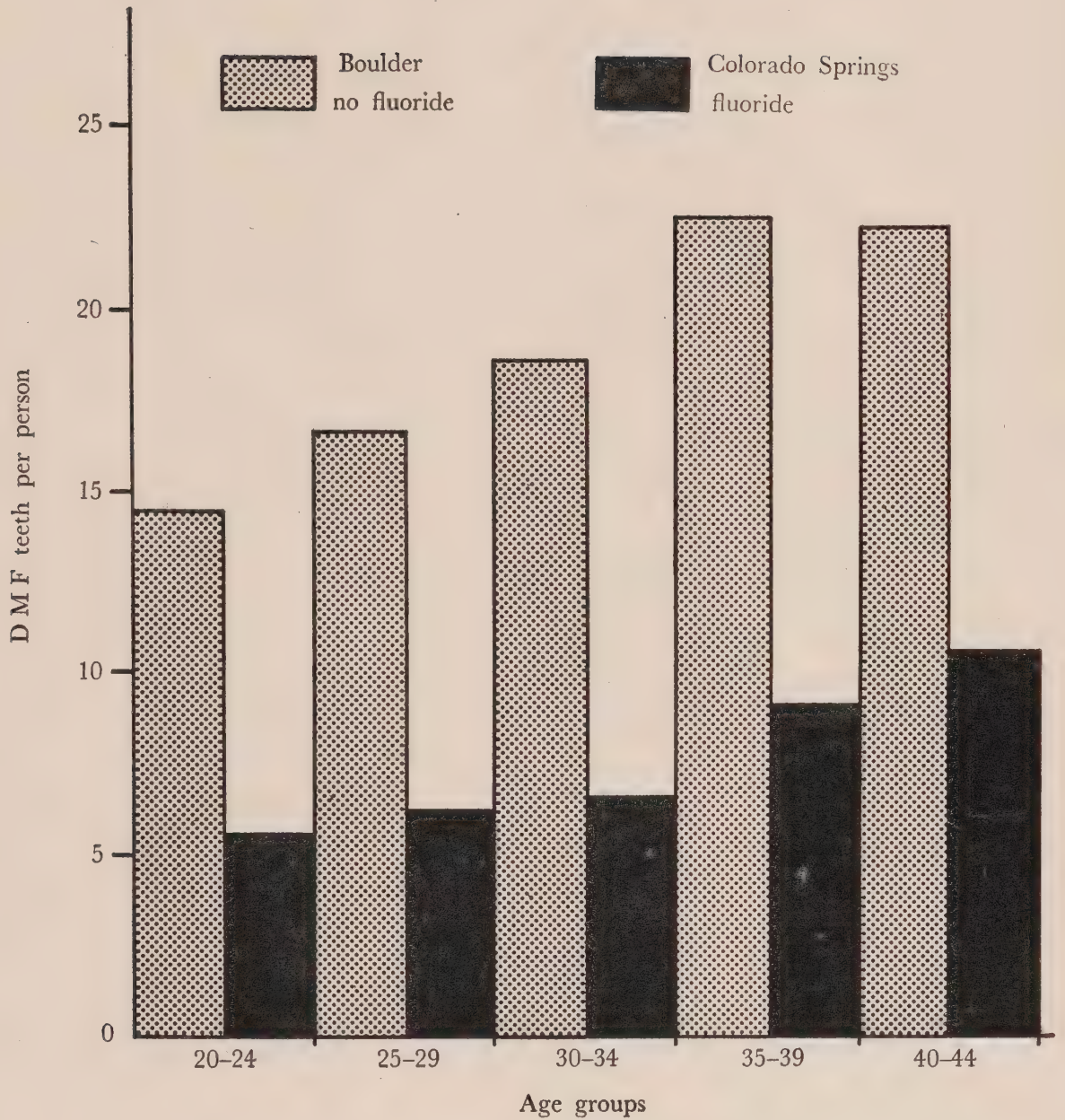


Fig. 3: DMF permanent teeth in native adults of Boulder, Colorado, using a fluoride-free water and native adults of Colorado Springs, Colorado, using a 2.5 ppm fluoride water.

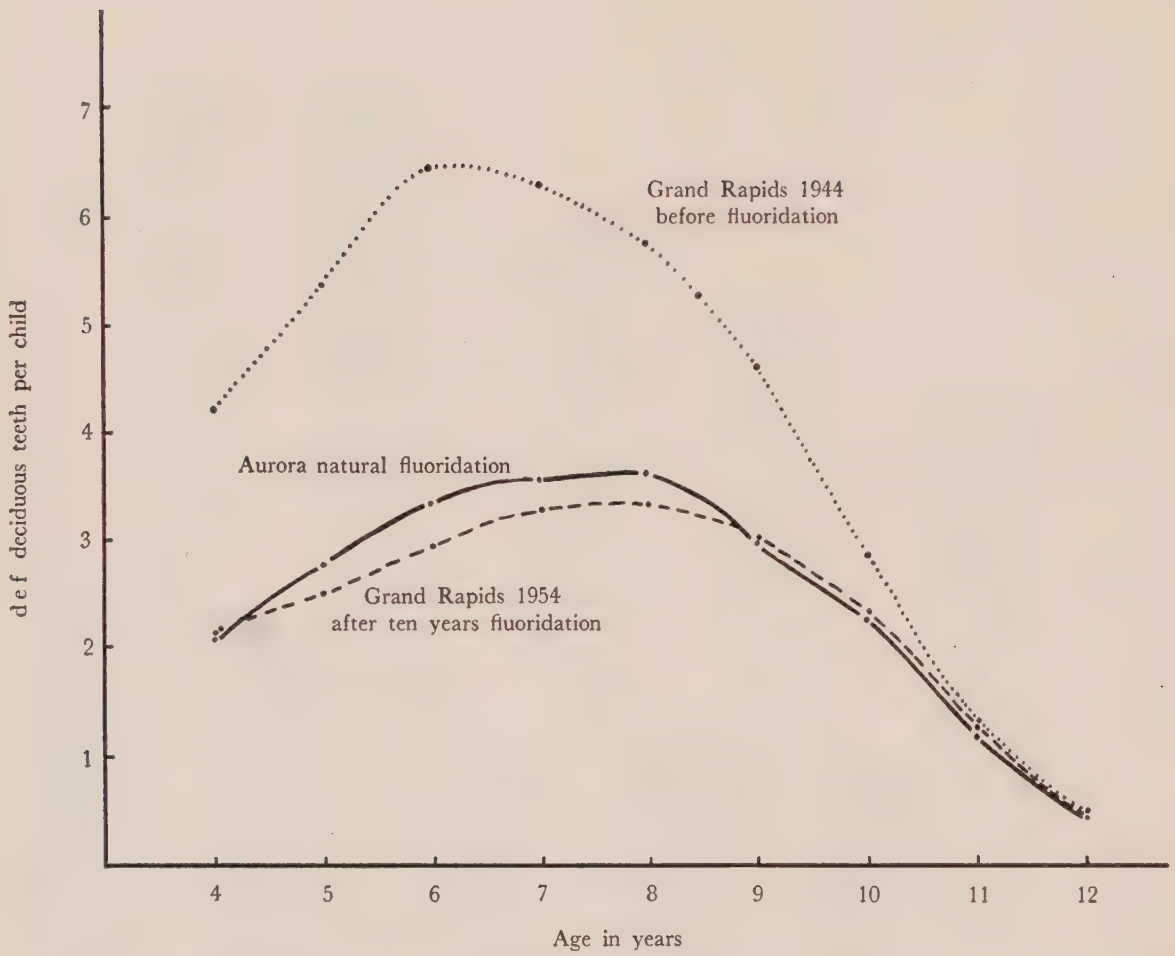


Fig. 4: Reduction in dental decay in deciduous teeth after ten years fluoridation at Grand Rapids.

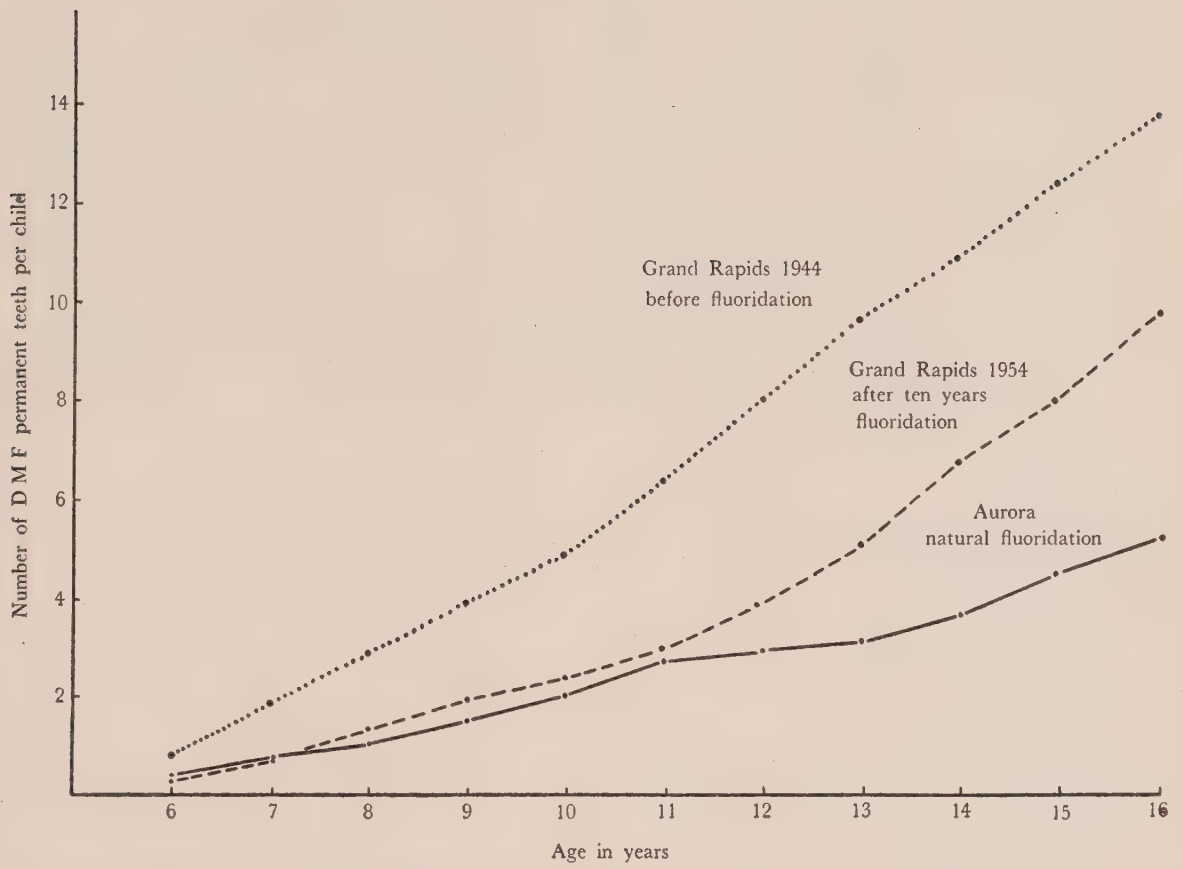


Fig. 5: Reduction in dental decay in permanent teeth after ten years fluoridation at Grand Rapids.

APPENDIX C
LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS

<i>Witness</i>	<i>Exhibit Reference</i>	<i>Evidence Ref. Vol.</i>	<i>Page</i>	<i>Details</i>
Colonel J. F. Fuller	A	1	28	“Dental Caries: The Experience and Treatment Requirements of Compulsory Military Training Recruits”, by G. N. Davies, D.D.S.(N.Z.). <i>The New Zealand Dental Journal</i> , Vol. 49, No. 236 - April 1953.
	B	1	28	“Dental Caries: The Experience and Treatment Requirements of Compulsory Military Training Recruits”, by G. N. Davies, D.D.S.(N.Z.). Unpublished.
	C	1	31	“Field Studies and Dental Caries”, by R. E. T. Hewat. <i>The New Zealand Dental Journal</i> , Vol. 44, No. 217 - July 1948.
	D	1	31	“Arizona School Changes Stand on Fluoridation”. Public Health Notes - <i>Journal of the American Dental Association</i> , Vol. 52, No. 1 - January 1956.
	E	1	36	“Should We Fluoridate Our Water Supplies”, by J. F. Fuller, B.D.S., F.D.S.R.C.S.(EDIN.). <i>The New Zealand Dental Journal</i> , Vol. 52, No. 247 - January 1956.
	F	1	37	“Fluorine in the Control of Dental Caries”, by H. T. Dean, D.D.S. <i>The International Dental Journal</i> , Vol. 4, No. 3 - March 1954.
	G	1	38	Chart - “Children with Caries-free Permanent Teeth - Sarnia-Brantford-Stratford 1948-54”, being Fig. 1 from “Brantford Fluoridation Caries Study - 1954 Report” Bowen <i>et al.</i> <i>The Canadian Dental Association Journal</i> , Vol. 20, No. 11 - November 1954.

G/1	1	39	Chart - "D M F' Permanent Teeth per Child - Sarnia-Brantford-Stratford 1948-54", being Fig. II from "Brantford Fluoridation Caries Study - 1954 Report" - Bowen <i>et al.</i> <i>The Canadian Dental Association Journal</i> , Vol. 20, No. 11 - November 1954.
H	1	41	"Effect of Fluoridated Public Water Supplies on Dental Caries Prevalence", by F. A. Arnold <i>et al.</i> United States Public Health Reports, Reprint No. 3274, Vol. 71, No. 7 - July 1956.
H/1	1	41	Graph - D M F Permanent Teeth per Child - Hastings, Napier, Grand Rapids (1944), Grand Rapids 1954, Aurora 1944 (unpublished).
I	1	45	"The Fluoridation of Domestic Water Supplies in North America as a Means of Controlling Dental Caries", Report of the United Kingdom Mission (February to April 1952). Her Majesty's Stationery Office 1953.
J	1	47	"Fluoridation of Public Water Supplies" - General News. <i>The Canadian Dental Association Journal</i> , Vol. 22, No. 9 - September 1956.
K	1	29-56	"Dental Caries in New Zealand", by Hewat and Eastcott, published by Medical Research Council of New Zealand.
L	1	43	Newsletter - New Zealand Dental Association Council on Dental Health Education, Vol. 4, No. 1 - 15 October 1956.
A	1	74	Chart - "Composition of Calcified Tissues of the Teeth".
B	1	75	Chart - "Fluorides Consumed in the Diet".
C	1	80 and 85	Table I - "Number of Teeth Decayed per 100 Erupted - Hastings and Kingston".
D	1	84	References to the literature.

Mr T. G. Ludwig

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—*continued*

<i>Witness</i>	<i>Exhibit Reference</i>	<i>Evidence Ref. Vol.</i>	<i>Evidence Ref. Page</i>	<i>Details</i>
Mr. T. G. Ludwig— <i>continued</i> ..	E	1	86	Table II – “Mean Number of Teeth Affected by Decay per Child in Hastings and Napier”.
	F	1	87	Table III – “Number of Permanent Teeth Affected by Decay per 100 Permanent Teeth Erupted in Hastings and Napier”.
	G	1	88	Table IV – “Mean Number of Deciduous Teeth Affected by Decay per Child in Hastings and Napier”.
	H	1	89	Table V – “Number of Deciduous Teeth Affected by Decay per 100 Teeth Erupted in Hastings and Napier”.
	I	1	90	Table VI – “Distribution According to Age and Sex of Children Examined in Hastings and Napier”.
	J	1	91	Table VII – “Number of Children with Mottled Enamel in Hastings and Napier”.
	K	1	92	Table VIII – “Consumption of Fluoride from Fluoridated Milk”.
	L	1	93 and 100	Table – “Consumption of Fluoride from Milk”.
	M	1	111	Letter of 22 October 1956 to Mr Ludwig from the Director of the Eastman Dental Institute.
Mr R. P. Fish ..	A	1	127	Advice note of 4 September 1952 from Imperial Chemical Industries Ltd. to Hastings Borough Council (now City Council) regarding first shipment of sodium silico-fluoride.
Mr W. E. Bate ..	A	1	129	Circular – “Women of Hastings” distributed by Anti-water Poisoning Campaign, Hastings.
	B	1	129	Anonymous Circular – “The Truth about Fluoride”.

C	1	129	Circular - "Fluoridation Facts" issued by New Zealand Voters' Policy Association and pamphlet, <i>Fluoridation Facts</i> , published by A. Wilkinson, Christchurch.
D	1	129	Circular - "Fluoridation of Water Supplies", issued by the New Zealand Voters' Policy Association.
E	1	130-133	The petition to the Mayor and Borough Councillors of Hastings
F	1	130	Joint Statement on Fluoridation of Water Supply, Hastings City Council and the Havelock North Borough Council.
G	1	129	Letter regarding fluoridation and pregnancy dated 20 April 1955 from Medical Officer of Health, Palmerston North, to the Mayor and Councillors of Hastings.
A	2	165	Chart - "Fluoride Content of Enamel of 89 New Zealand Subjects".
B	2	167-168	Diagram - "Atomic Structure of Fluor-apatite."
C	2	172	Chart - "Total Daily Intake of Fluoride to Give a Clinical Effect".
D	2	183	Chart - "Daily Fluoride Intake."
A/1	9	1216	Letter from H. M. Sinclair, and D. C. Wilson.
A/2	9	1216	Letter from United Kingdom Mission.
A/3	9	1216	Letter from H. M. Sinclair and D. C. Wilson.
A/4	9	1216	Letter from N. J. Ainsworth
A/5	9	1216	Letter from Angus M. Thomson (Member, United Kingdom Scientific Mission to North America on Fluoridation).
A/6	9	1216	British Ministry of Health statement.
A/7	9	1216	Letter from F. H. Kemp and D. C. Wilson.
B/1	9	1216	Papers in process of publication: Dr W. T. C. Berry, Medical Officer, British Ministry of Health, and others. "Studies in High- and Low-fluoride Areas in Great Britain".
Dr Muriel E. Bell	..	..	..

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—continued

Witness	Exhibit Reference	Vol.	Evidence Page	Ref. Page	Details
Dr Muriel E. Bell—continued	C/1	9	1216	1216	“Wilson on Fluoride and Goitre”: criticism by Dr G. Wynne Griffith.
	D/1	9	1216	1216	“Medical Aspects of Fluoridation”: Edward R. Schlesinger.
	E/1	9	1216	1216	“Use of Fluoride Compounds in Prevention of Dental Caries”: Edward R. Schlesinger and David B. Ast.
	F/1	9	1216	1216	“Fluoridation in the Public News”: <i>American Journal of Public Health</i> .
	1/A	9	1216	1216	“Comments on Waldbott’s ‘Medical evidence against Fluoridation’ ”: Personal communication to Dr Muriel E. Bell from Dr W. T. C. Berry.
	1/B	9	1216	1216	“Preliminary Analysis of the Circular ‘Medical Evidence Against Fluoridation’, by George L. Waldbott.” C. V. Tossey, D.D.S., and J. Roy Doty, PH.D.
	1	7	921	921	“Nutrition Statement on Water Fluoridation”, prepared by Dr Norman Jolliffe of the New York City Health Department, dated 13 November 1956.
	2	7	926	926	Extract from Report of the British Ministry of Health – Part I and Part II.
	3	7	929	929	Extracts from Chemical Abstracts – (a) 50, 17205, November 1956; and (b) Nutrition Abstracts and Reviews, 25, 1955, p. 245, Abstract 1263.
	4	7	931	931	Letter dated 8 February 1957 from A. L. Russell to Dr Ionel Rapaport.
	5	7	931	931	Letter dated 27 February 1957 from A. L. Russell to Dr George N. Davies.

6	7	931	Letter dated 28 February 1957 from the Ministry of Health, London, to Dr Bell.
7	7	931	Copy of Report by Dr Ionel Rapaport published in <i>Bulletin de l'Academie Nationale de Medecine</i> , 6 November 1956.
8	7	949	Paper by G. Wynne Griffith - "Some Medical Considerations of Fluoridation".
9	7	949	Paper by J. Longwell, D.Sc., F.R.I.C. - "Fluoridation of Water Supplies".
A	3	319	Newsclipping from <i>Hawke's Bay Herald-Tribune</i> of 29 August 1956 - Two letters from Nelson M. Fuller, U.S.A. and Mr E. Vogther to the editor.
B	3	315 and 324	Report on American TV broadcast of 18 September 1955.
A	3	342	Booklet - <i>Fluoridation Unmasked</i> , by Fanchon Battelle.
B	3	342	Letter dated 12 March 1956 from the Department of Health to Mrs Gale.
C	3	342	Reply to Mrs Gale from the Dominion Laboratory dated 21 March 1956.
D	3	343	Letter from the Department of Health to Mrs Gale dated 6 April 1956.
E	3	343	Letter from Dr Leo Spira to Mrs Gale dated 7 February 1956.
F	3	343	Letter from Dr Leo Spira to Mrs Gale dated 6 April 1956.
1 to 5	3	372	Pamphlet - "Housewives Today", five copies published from January 1954 to September 1956.
A	3	375	Newsclipping - "Water Fluoridation Potentially Harmful" from the <i>Evening Post</i> - 8 October 1956
1/A	4	418 and 448	Tables 1 to 31.
1	4	449	Chart No. 1 - Percentage of New Zealand Children with One or More Decayed Deciduous Teeth.
Mr E. G. Gamble	..	..	..
Mrs E. B. Gale	..	..	..
Mrs A. Hogg	..	..	..
Mr A. N. S. Moore	..	..	..
Dr G. N. Davies	..	..	..

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—*continued*

<i>Witness</i>	<i>Exhibit Reference</i>	<i>Evidence Ref. Vol.</i>	<i>Page</i>	<i>Details</i>
Dr G. N. Davies— <i>continued</i>	2	4	450	Chart No. 2 – Percentage of New Zealand Children with One or More Decayed Permanent Teeth.
	3	4	451	Chart No. 3 – Prevalence of Dental Decay in New Zealand.
	4	4	453	Chart No. 4 – Prevalence of Dental Caries in New Zealand.
	5	4	454	Chart No. 5 – The Annual Increment of Dental Decay.
	6	4	456	Chart No. 6 – Percentage Distribution of New Zealand Denture Wearers by Age Groups.
	7	4	458	Chart No. 7 – Previous Treatment and Dental Caries Experience Among New Zealand Military Training Recruits.
	8	4	459	Chart No. 8 – Prevalence of Periodontal Disease in New Zealand.
	9	4	460	Chart No. 9 – Prevalence of Dental Decay in Relation to the Natural Fluoride Content of the Water.
	10	4	464	Chart No. 10 – D M F Permanent Teeth in Native Adults of Boulder, Colorado, Using a Fluoride-free Water and Native Adults of Colorado Springs, Colorado, Using a 2.5 ppm Fluoride Water.
	11	4	465	Chart No. 11 – Reduction in Dental Decay in Deciduous Teeth after Ten Years Fluoridation at Grand Rapids.
	12	4	467	Chart No. 12 – Reduction in Dental Decay in Permanent Teeth after Ten Years Fluoridation at Grand Rapids.
	13	4	469	Chart No. 13 – Fluoride Concentrations (in ppm) in Successive Layers of Enamel from Areas with 0.1, 1.0, and 5.0 ppm Fluoride in the Water Supplies.

14	4	473	Chart No. 14 – Prevalence of Detectable Dental Fluorosis in Relation to the Natural Fluoride Content of the Water Supply.
15	4	475	Chart No. 15 – Prevalence of Dental Decay in New Zealand Compared with Three Areas in U.S.A. and Canada.
16	4	477	Chart No. 16 – Toffee Group – 48 males.
17	4	478	Chart No. 17 – Caramel Group – 62 males.
19	4	480	Chart No. 19 – Dental Caries Experience and the Influence of Dietary Control.
20	4	481	Chart No. 20 – Effective Dietary Replacement Therapy Upon the Incidence of Dental Caries.
A	4	485	Report to the Minister of Health, Province of Ontario, Canada, on “the Brantford Fluoridation Experiment”. Extract from the <i>Canadian Dental Association Journal</i> .
B	4	491	“A Roentgenologic Study of a Human Population Exposed to High Fluoride Domestic Water” – reprinted from the <i>American Journal of Roentgenology, Radium Therapy, and Nuclear Medicine</i> , Vol. LXXIV, No. 5, November 1955.
C	4	491	“Review of the Bartlett-Cameron Survey: the Ten-year Fluoride Study” – reprinted from <i>Journal of the American Dental Association</i> , Vol. 50, March 1955.
D	4	492	Statement by Dr W. Van Heuvelen of North Dakota State Department of Health – Nature of Ions.
E	4	492	Statement by Arthur B. McWhinnie – Number of Ways of Selecting Positive Dosage of Fluoride.
F	4	494	Extract from the <i>Journal of the British Medical Association</i> , 2 April 1955 – copy of a letter from Frederick C. Endean, F.R.C.S., London S.W. 1.

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—continued

Witness	Exhibit Reference	Vol.	Evidence Ref. Page	Details
Dr G. N. Davies—continued	G	4	495	Ministry of Health, London. Reference note No. 9, July 1955, "The Fluoridation of Water and the Prevention of Dental Decay".
	H	4	497	Report of Committee of the St. Louis Medical Society — "Water Fluoridation", reprinted from <i>Missouri Medicine</i> , February 1954.
	I	4	497	Chronic Illness Newsletter, Vol. 5, No. 4, of April 1954, issued by the Commission on Chronic Illnesses, U.S.A.
	J	4	497	Newburgh-Kingston Caries — Fluorine Study: Final Report. Reprinted from the <i>Journal of the American Dental Association</i> , Vol. 52, March 1956.
	K	4	498	Medical Aspects of Excessive Fluoride in a Water Supply — U.S. Public Health Reports, Reprint No. 3242, Vol. 69, No. 10, October 1954.
	L	4	498	"Digest of Opinions on Fluoridation", compiled by the Health League of Canada.
	A-1	5	509	Correspondence between Dr W. B. Prothro and Dr G. N. Davies
	B-1	5	509	Correspondence between Professor R. A. Peters and Dr G. N. Davies.
	C-1	5	510	Correspondence between Professor H. V. Smith and Dr G. N. Davies.
	D-1	5	511	Copy of letter from Robert S. Harris to Dr D. Taylor.
	E-1	5	511	Copy of letter from Professor G. W. Rapp to Dr D. Taylor.
	F-1	5	511	Comments by Professor F. R. Shroff on the pulp changes attributable by Charles Dillon to the action of fluoride.

- A/1/1 4 412 "Tenth year of the Grand Rapids-Muskegon Study," by F. A. Arnold, jun., H. T. Dean, Philip Jay, and J. W. Knutson. "Effect of Fluoridated Public Water Supplies on Dental Caries Prevalence." *Pub. Health Repts.* 71 : 652-8, July 1956.
- A/1/2 4 412 "Newburgh-Kingston Caries - Fluorine Study," XIV., by D. B. Ast, D. J. Smith, Barnet, Wacks, and Katherine T. Cantwell. "Combined Clinical and Roentgenographic Dental Findings after Ten Years of Fluoride Experience." *Journal of the American Dental Association* 52 : 314-25, March 1956.
- A/1/3 4 412 "Prevalence of Periodontal (Paradontal) Disease 2. In Australasia", by W. M. Cunningham. *Internat. Dent. Journal*, 5 : 200-8, June 1955.
- A/1/4 4 412 "Studies on Dental Caries in New Zealand. I. The Annual Increment of Dental Caries - a Challenge to Organised Dentistry", by G. N. Davies and R. M. King. *New Zealand Dental Journal*, 47 : 134-7, July 1951.
- A/1/5 4 412 "The Effectiveness of an Ammonium Ion Toothpowder in the Control of Dental Caries", by G. N. Davies and R. M. King. *Journal of Dental Research*, 30 : 645-55, October 1951.
- A/1/6 4 412 "Ammoniated Dentifrices and Caries Control", by G. N. Davies. *New York State Dental Journal*, 19 : 19-24, January 1953.
- A/1/7 4 412 "Studies on Dental Caries in New Zealand. II. Dental Caries Experience and Treatment Requirements of Compulsory Military Training Recruits", by G. N. Davies. *New Zealand Dental Journal*, 49 : 92-8. April 1953.

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—continued

<i>Witness</i>	<i>Exhibit Reference</i>	<i>Evidence Ref. Vol.</i>	<i>Evidence Ref. Page</i>	<i>Details</i>
Dr G. N. Davies—continued . .	A/1/8	4	412	“Survey of Denture Wearers in New Zealand” by G. N. Davies, J. P. Walsh. <i>New Zealand Dental Journal</i> , 49: 124-30, July 1953.
	A/1/9	4	412	“Dental Difficulties of Pre-school Children”, by G. N. Davies. <i>New Zealand Medical Journal</i> , 53 : 389-95, August, 1954.
	A/1/10	4	412	Newsletter - “Fluoridation”, Vol 3, No. 1., by G. N. Davies. J. McIndoe, Dunedin, 20 February 1955.
	A/1/11	4	412	“An Appreciation of the Vipeholm Study of Dental Caries”, by G. N. Davies. <i>New Zealand Dental Journal</i> , 51 : 153-7, October 1955.
	A/1/12	4	412	Newsletter - “Fluoridation”, Vol. 4, No. 1, by G. N. Davies. J. McIndoe, Dunedin, 15 October 1956.
	A/1/13	4	412	“An Independent Assessment of the Results of the Newburgh-Kingston Fluoridation Study”, by G. N. Davies. In press.
	A/1/14	4	412	“Fluorine in the Control of Dental Caries. Some Aspects of the Epidemiology of the Fluorine-Dental Caries Relationship”, by H. J. Dean. <i>International Dental Journal</i> , 4 : 311-37, March 1954.
	A/1/15	4	412	“The Effect of Artificial Water Fluoridation on the Solubility of Tooth Enamel”, by S. B. Finn and Charles de Marco. <i>Journal of Dental Research</i> , 35 : 185-8, April 1956.

- A/1/16 4 412 "Caries Incidence and Enamel Defects in Areas with Different Levels of Fluoride in the Drinking Water", by Jean R. Forrest, *British Dental Journal*, 100 : 195-200, 17 April 1956.
- A/1/17 4 412 "Fluorine Content of New Zealand Teeth", by Marion F. Harrison. *New Zealand Dental Journal*, 45 : 2-27, January 1949.
- A/1/18 4 412 "Fluorine and Dental Caries in New Zealand", by Marion F. Harrison. New Zealand Science Congress, 1947.
- A/1/19 4 412 "The Evanston Dental Caries Study. XVI. Reduction in Dental Caries Attack Rates in Children Six to Eight Years Old", by I. N. Hill, J. R. Blayney, and W. Wolfe. *American Dental Association Journal*, 53 : 327-33, September 1956.
- A/1/20 4 412 Prophylaxie de la carie dentaire per les comprimés Fluores: premiers resultats. Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften. A. J. Held, and F. Pignet, 10 : 249-59, October 1954.
- A/1/21 4 412 "Fluoridation" - Observations of a German Professor and a Public Health Officer. H. Hornung. A. M. Dent, A. J. 53 : 325-6, September 1956.
- A/1/22 4 412 "Dental Caries in New Zealand", by R. E. T. Hewat and D. F. Eastcott. Medical Research Council of New Zealand, 1956.
- A/1/23 4 412 "The Biology of the Children of Hopewood House, Bowral, N.S.W. 1. Observations on Dental Caries Extending over Five Years (1947 to 1952)". B. Lilienthal, N. E. Goldsworthy, H. R. Sullivan, and D. A. Cameron. *Medical Journal of Australia*, 1 : 878-88, June 1953.

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS---continued

Witness	Exhibit Reference	Vol.	Evidence Ref. Page	Details
Dr G. N. Davies---continued	A/1/24	4	412	"The Efficacy of Caries Control Measures", by N. D. Martin. <i>Australian Journal of Dentistry</i> , 55 : 247-55, August 1951.
	A/1/25	4	412	"Launch Campaign to Spur Fluoridation", by B. J. Spoch. <i>American Dental Association Journal</i> , 53 : 106-8, July 1956.
	A/1/26	4	412	"Fluorine and Wartime Diet", by R. Weaver. <i>British Dental Journal</i> , 88 : 231-9, May 1950.
Mr L. H. James	A	2	214	Method of Determination of Fluorine in Water.
	B	2	215	Fluorine Analysis of Urine.
	C	2	217-219	Summary of Fluorine Analysis of Hastings Water 1953.
	D (1)	2	220	Fluorine Content of Water Supplies of Auckland.
	D (2)	2	222-227	Fluorine Content of Many New Zealand Water Supplies.
	E	2	221	Fluorine Content of Fluoridated Hastings Water from 20 September 1954 to 19 September 1956.
Dr J. F. P. Mangos	A	3	257	Letter endorsing fluoridation dated 21 November 1956 from Professor J. P. Walsh to Hon. Secretary, New Zealand Dental Association.
Mr J. S. Hannah	A	3	299	Photograph of sodium silico-fluoride sack.
	B	3	303	Photograph of a sack type container.
	B/1	3	300	Copy of Notes of Evidence taken before Mr Justice Turner in <i>Hannah v. Mayor, Councillors, and Citizens of the Borough of Hastings</i> (1956).
	C	3	302	Photograph of a sack with the words "Sodium - Poison - Fluoride - British Origin" imprinted thereon.
	D	3	304	Circular - "Resolution Opposing Mass Medication".

- E 3 305 Letter dated 2 June 1956 from Miss A. M. Constantine, Ministry of Housing and Local Government, London S.W. 1 to Mr J. S. Hannah.
- F 3 305 Letter dated 20 April 1956 from Dr G. L. Waldbott to Mr J. S. Hannah.
- G 3 305 Letter dated 29 October 1956 from the Dean, the Dental School of the University of Melbourne (Australia), to Mr J. S. Hannah - regarding an attached copy of a letter by A. B. P. Amico and Paul Pincus, which letter is an extract from the *Medical Journal of Australia* of 20 October 1956.
- H 3 305 Newsclipping - "Fluoridation Vigorously Opposed by Hastings Organisation" - *The Standard* - 15 August 1956.
- I 3 306 Letter from Dr G. L. Waldbott (undated).
- J 3 304 Newsclipping "Alarming Claims against Fluoridation Should be Investigated" - *The Standard* - 4 July 1956.
- 1 3 387 Hastings Public Protection Committee reference to Salk vaccine in connection with poliomyelitis.
- 2 3 387 Pamphlet - *Compulsory Mass Medication Threatens Individual Rights* - radio talk by Eric D. Butler. Republished by the Victorian Anti-fluoridation Association (Australia).
- 3 3 387 Letter dated 9 October 1956 from Association of American Physicians and Surgeons Inc., Chicago, to Mr J. S. Hannah.
- 4 and 1/D 3 387 Publication - *Fluoridation of Public Water Supplies*, by F. B. Exner.
- 5 3 388 Paper entitled "A Charge and a Wager" dated 10 January 1955 signed by Lt.-Col. Robert J. H. Mick, 5th General Hospital, A.P.O. 154, N.Y.

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—continued

Witness	Exhibit Reference	Evidence Ref.		Details
		Vol.	Page	
Mr J. S. Hannah—continued	6	3	388	Letter dated 30 August 1955 from Douw. G. Steyn, Pretoria, South Africa, to Dr Eva E. Hill, Ruakaka.
	7	3	388	Letter dated 3 October 1955 from C. M. McCay, Cornell University, Ithaca, to Dr Eva E. Hill.
	8	3	388	Three letters from Dr Spira, New York, to Mr J. S. Hannah.
	9/1	3	388	Pamphlet - <i>Chronic Fluorine Intoxication from Drinking Water</i> , by G. L. Waldbott.
	9/2	3	388	Pamphlet - <i>Pathological Findings in Fluorine Intoxication</i> , by Leo Spira.
	9/3	3	388	Pamphlet - <i>Prevention</i> , Vol. 6, No. 7, July 1954.
	9/4	3	388	Pamphlet - <i>Chronic Fluorine Poisoning (Fluorosis), Signs and Symptoms</i> , by Leo Spira.
	9/5	3	388	Pamphlet - <i>A Water Supply Perspective of the Fluoridation Discussion</i> , by Benjamin C. Nesin.
	1/A	9	1298	A letter and pamphlet <i>Urinary Calculi and Fluorine</i> , by Leo Spira.
	1/B	9	1303	Copy of letter dated 15 October 1956 from W. L. Braughn, Secretary to the Association of American Physicians and Surgeons Inc. regarding opposition to mass medication.
	1/C	9	1303	Pamphlet - <i>Failure of Fluoridated Water Supply to Prevent Dental Decay</i> , by K. K. Paluev.
	1/D	9	1303	See Exhibit 4 (above).
	1/E	9	1303	Pamphlet— <i>The Processing of Food and the Contamination of Food and Beverages by Chemicals</i> , by Douw. G. Steyn.

Mr F. Allen	..	..	A	5	636	Article - "A Water Supply Perspective of the Fluoridation Discussion", by B. J. Nesen, 8 February 1956.
			B	5	645	List of communities which have discarded fluoridation as at June 1956.
Mr M. V. Ross	..	..	A	5	628	Publication - "The Drama of Fluorine", by Leo Spira, M.D. (PH.D. (MED.)).
Mr A. G. Grove	..	..	A	6	681	"Homoeopathy Considers Heart Disease", article by A. H. Grimmer, M.D.
			B	6	682	"The Fluorides", article by A. J. Shadman.
			C	6	684	Extracts from the <i>Dictionary of Homoeopathy Materia Medica</i> .
			D	6	686	"Calcareo Fluorica, etc. - Extracts from 66 Rheumatic Remedies", by H. A. Roberts, M.D.
			E	6	692	"Fluoric Acid from Lectures on Homoeopathic Materia Medica", by Professor J. T. Kent.
			F	6	700	Booklet referred to by witness, passed in, and subsequently returned, by Dr N. L. Edson, after consideration of the contents.
Dr Eva E. Hill	..	..	A	6	750	Technical Bulletin No. 45 - University of Arizona, 1 January 1933 - "Experimental Production of Mottled Enamel", by C. M. Smith and Edith M. Lantz.
			B	6	750	Copy of letter from Professor Steyn to Editor, Rand Daily Mail, Johannesburg, of 8 October 1954.
			C	6	751	Article - "Fluoridation of Water", by Major Geo. Racey Jordon.
			D	6	752	Picture from "Fluoridation Story", periodical depicting protective clothing worn by personnel handling fluorides.
			E	6	756	Photostat copy of extract from the <i>Grand Rapids Press</i> , 27 July 1955.
			F	6	757	Extract from publication H.R. 2341.

<i>Witness</i>	<i>Exhibit Reference</i>	<i>Evidence Ref. Vol.</i>	<i>Page</i>	<i>Details</i>
Dr Eva E. Hill— <i>continued</i>	G	6	758	Minutes of Meeting, Fourth Annual Conference of State Dental Directors with Public Health Service and the Children's Bureau - 6 and 8 June 1951.
	H	6	759	Remarks of Dr A. L. Miller - extract from "U.S. Congressional Record" of 83rd Congress, First Session.
	I	6	759	Material of the Auckland Fluoridation Committee.
	J	6	759	Report of the Delaney Committee to Investigate the Use of Chemicals in Foods and Cosmetics.
	K	6	759	Article by Geo. L. Waldbott "No Harm from Fluoridated Drinking Water".
	L	6	759	Periodical - "The National Fluoridation News", Vol. 1, No. 208, September 1955.
	M	6	722 and 759	Extract from H.R. 2341: Statement by F. B. Exner.
	N	6	738 and 760	"Medical Evidence Against Fluoridation of Public Water Supplies", by G. L. Wadlbott - reproduced from the <i>Australian Journal of Dentistry</i> , February 1955.
	O	6	768	Periodical - "National Fluoridation News", Vol. 11, No. 1, January 1956. Letter from Leo Spira, M.D.
	O/1	9	1188	Letter dated 12 March 1951 from John D. Frisch, D.D.S., to Dr Royal Lee.
	O/2	9	1189	Letter dated 19 March 1951 from Dr Royal Lee to Dr Frisch.
	O/3	6	761	Letter by Charles E. Perkins to Lee Foundation for Nutritional Research, Milwaukee.
	P	6	769	Extract from Stockholm newspaper dated 2 March 1955 - "Sweden Prohibits Fluoridation".

Mrs M. I. Stroobant	..	Q	6	774	Letter from Secretary, Fluoridation Educational Society, to Dr Eva Hill, dated 12 November 1956.
	..	R	6	748	Letter from C. T. Betts, D.D.S., to Edwin R. Van Kleeck, dated 26 October 1954.
	..	A	6	786	List of communities which have discarded fluoridation as at 1 September 1956.
Professor J. P. Walsh	..	A	7	805	A statement by the Council on Legislation of the American Dental Association being a "Review of the Court Decision on the Subject of Fluoridation of Public Water Supplies".
	..	B	7	806	Slides depicting dental diseases.
Professor F. R. Shroff	..	A	7	826	Article - "Bone Contact Removes Fluorine", by H. V. and M. C. Smith, reprinted from <i>Water-works Engineering</i> , 10 November 1937.
	..	B	7	826	Article - "A Practical Method of Removing Fluorine from Water", by H. V. Smith, from Proceedings of the Sixth Pacific Science Congress of the Pacific Science Association 1939.
	..	C	7	827	Article - "Removal of Fluorides from Potable Water by Tricalcium Phosphate", by Adler, Klein, and Lindsay (1938) in the <i>Journal of Industrial and Engineering Chemistry</i> , Vol. 30, page 163.
	..	D	7	827	"Defluoridation of Municipal Water Supplies", by F. J. Maier.
Sir Charles Hercus	..	A	7	843	Letter dated 8 March 1957 from Professor M. C. Sosman to Sir Charles Hercus.
Dr. W. M. Cunningham	..	A	7	853	Article - "Fluoridation and Periodontal Disease", by H. K. Box, D.D.S., <i>Dental Digest</i> 61: 172, April 1955.
Mrs E. H. M. McInnes	..	A	7	871	Booklet - "Fluoridation and Tooth Health", by C. Leslie Thomson, B.Sc., Edinburgh.

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—continued

Witness	Exhibit Reference	Vol.	Evidence Ref. Page	Details
Miss R. S. Andrew	A	7	876	List of Members - Dunedin Anti-fluoridation Society.
Mr F. Broomfield	A	7	893	Booklet - <i>Soil Fertility as the Basis of Public Health</i> , No. 13, October 1945.
	B	7	896	Newsclipping <i>Evening Star</i> , 7 March 1957 - "Significance Attached to Idea: We are What we Eat".
Madam Mira Louise James	A	7	900	Booklet - <i>Protection from Polio and Animal Research</i> , by Mira Louise.
	B	7	912	"An Authoritative Article on Water Supply Fluoridation", by W. A. Morrison, D.D.S. <i>The Dental Magazine and Oral Topics</i> , Vol. 71, No. 1, March 1954.
	C	7	918	Booklet - <i>The Menace of Cow's Milk</i> , by Mira Louise.
Mr R. S. Malthus	A	7	983	Article - <i>Advances in Experimental Caries Research - General Summary</i> , editor R. F. Sognnaes, published by the American Association for the Advance of Science 1955.
Dr E. C. Mudie	A	7	969	"Fluorosis in Nalgondia", <i>British Medical Journal</i> , 10 December 1955.
Mr W. R. Hamilton	A	8	989	Pamphlets and posters on various dental matters produced and distributed by the Council on Dental Health Education of the New Zealand Dental Association.
Mr J. Francon Williams	A	8	1011	Pamphlet - <i>Fluoridation Facts</i> , published by A. Wilkinson.
	B	8	1011	<i>What You Should Know about Fluoridation of Municipal Water Supplies</i> , distributed by R. W. Nagle, Auckland.
	C	8	1011	Pamphlet - <i>Facts about Fluoridation of Water Supplies</i> , compiled by Dr Eva Hill.

D	8	1011	Pamphlet—75 <i>Reasons Why Community Water Supplies Should not be Fluoridated</i> , by W. D. Herrstrom.
E	8	1012	Paper by Dr Norman Jolliffe of New York City Health Department—13 November 1956.
F	8	1017	Letter dated 10 March 1956, from Intelligence Officer, Ministry of Health, London.
G	8	1021	“Mottled Teeth in Great Britain”, by Leo Spira. <i>British Dental Journal</i> , Vol. LXXIII, No. 6, 15 September 1942.
H	8	1024	Booklet—“Fluoridation in the Prevention of Dental Caries”. <i>American Dental Association Journal</i> , February 1951.
I	8	1025	Paper—“Fluoridation of Public Water Supplies”, by F. J. Maier, presented on 17 September 1950 at South West Section Meeting, New Orleans.
A	8	1044	“The Fluoridation Issue”— <i>Awake</i> , 22 March 1956.
A	8	1072	Report prepared for the city of New York on Fluoridation, by F. B. Exner.
A	8	1090	Board and Council (<i>New Zealand Local Authorities Review</i>), Vol. XXXIV, No. 866, of 22 August 1955.
B	8	1091	Board and Council (<i>New Zealand Local Authorities Review</i>), Vol. XXXIV, No. 862, of 2 June 1955.
A	8	1132	Article “Medical Evidence Against Fluoridation of Public Water Supplies”, by G. L. Waldbott. Extract from <i>Australian Journal of Dentistry</i> , February 1955.
A	8	1141	The <i>British Medical Journal</i> , 10 December 1955. (Page 1408.)
A	9	1174	“Fluoridation of Drinking Water—National Health and Medical Research Council”. <i>Dental Journal of Australia</i> , February 1954.
A	9	1179	Folio of “Reprints and Articles on Fluorine”.

LIST OF EXHIBITS PRODUCED AT PUBLIC HEARINGS—continued

Witness	Exhibit Reference	Evidence Ref. Vol.	Page	Details
Dr U. G. Williams ..	A	9	1195	Booklet - <i>The Truth About Fluoridation</i> , by Charles E. Perkins, 2nd Edition.
Mr A. H. Jecks ..	A	8	1001	Letter dated 18 March 1957 setting out water-supply costs for the year ending 31 March 1956 for the city of Christchurch.
Mr W. A. G. Penlington ..	A	9	1196	Twenty-five letters from citizens of Hastings on alleged effects of drinking fluoridated water.
	B	9	1197	Booklet - <i>Fluoridation of Water Supplies</i> , by Dr G. L. Waldbott.
Mr J. K. Johannesson ..	A	9	1262	Paper - "A Simple Automatic Apparatus for the Distillation of Fluorine as Hydrofluosilicic Acid".
	B	9	1263	Booklet - <i>Fluoridation Equipment</i> , by Wallace and Tierman.
	C	9	1263	Pamphlet of the Foxboro Co.
	D	9	1264	Copy of extract from "Standard Methods of Water Analysis".
	E	9	1264	"Proceedings of the Society for Water Treatment and Examination".
	F	9	1264	Journal of the American Waterworks Association.
	G	9	1265	Copy of "Fluoridation by Automatic Control".
Mr W. M. Cameron ..	A	9	1276	Booklet - <i>Fluoridation Equipment</i> , by Wallace and Tierman.
Dr H. B. Turbott ..	A	10	1311	Variety of publicity material produced by the Health Education Branch, Department of Health.
Dr J. B. Bibby ..	A	10	1319	Folder - <i>Dental Treatment for Your Child</i> .
	B	10	1319	Folder - <i>Care of Your Child's Teeth</i> .
	C	10	1319	Folder - <i>Clean Teeth - a Notice to Parents</i> .
	D	10	1319	Folder - <i>The School Dental Nurse and Your Child</i> .

E	10	1320	Folder - <i>Your Child's Dental Future</i> .
F	10	1320	Booklet - <i>Sound Teeth for Teenagers</i> .
G	10	1320	Copies of newspaper advertisements on dental health.
H	10	1320	Booklet - <i>School Dental Service Gazette</i> , Vol. XVI, No. 6, November 1956.
I/1 to I/6	10	1320	Pamphlets on children's dental health.
I/A	1	55	Letter of 6 August 1956 from Secretary to Medical Research Council of New Zealand to Mr W. A. G. Penlington.
1	3	331	Letter of 21 September 1955 from David B. Ast to Dr F. S. Maclean regarding alleged discrepancy of dental caries picture - the Newburgh-Kingston study.
2	6	770	Copy of advertisement - the <i>Hawke's Bay Herald-Tribune</i> of 27 October 1955.
3	6	777	Periodical - <i>Dental Health Highlights</i> , Vol. 11, No. 10, 1 October 1955.
A	8	1076	Pamphlet - <i>Fluoridation is Mass Murder</i> , distributed by A. A. Lind, Dunedin.
B	10	1387	Copy of extract "Hastings Suggested as Centre for Dental Caries Experiment", from the <i>Hawke's Bay Herald-Tribune</i> , 16 March 1951.
C	10	1388	Copy of extract "Fluorine Project - experiment on Hastings Water Supply Material to Hand," from the <i>Hawke's Bay Herald-Tribune</i> , 13 October 1951.

Counsel for the Hastings Anti-fluoridation Society

Counsel assisting the Commission

APPENDIX D

List of persons who gave evidence or tendered submissions either individually or on behalf of organisations at public hearings.

<i>Witness</i>	<i>Official Position or the Organisation Represented</i>
Professor C. C. Aikman, Wellington	.....
Mr F. Allen, Auckland .	Auckland Anti-fluoridation Society.
Miss R. S. Andrew, Dunedin .	Dunedin Anti-fluoridation Society.
Mr H. R. Bach, Lower Hutt .	City Engineer, Lower Hutt City Council.
Professor C. L. Bailey, Wellington	.....
Mr W. E. Bate, Hastings .	Mayor of Hastings city (elected November 1953).
Dr N. C. Begg, Dunedin .	Dominion Executive of the Plunket Society.
Dr Muriel E. Bell, Dunedin .	Nutritionist to the Department of Health.
Mr J. R. Benson, Dunedin .	Otago Branch of the New Zealand Dental Association.
Dr J. D. Bergin, Wellington .	.....
Dr J. B. Bibby, Wellington .	Director, Division of Dental Hygiene, Department of Health.
Mr E. W. Boulton, Otahuhu .	Papatoetoe Anti-fluoridation Society.
Mr E. J. Bradshaw, Riccarton .	Mayor of Riccarton borough.
Mr F. Broomfield, Dunedin .	.....
Mr R. D. Brown, Hastings .	Former Mayor of Hastings (in office from 1947 to 1953).
Dr C. R. Burns, Wellington .	Member of the Nutrition Research Committee of the Medical Research Council of New Zealand.
Mr W. M. Cameron, Wellington	.....
Professor H. McK. Carey, Auckland	Auckland Division of the British Medical Association.
Mr J. S. Carmichael, Wellington	Waterworks Engineer, Wellington City Council.
Mrs F. Cater, Hastings .	.....
Mr F. C. Cooper, Christchurch	New Zealand Organic Compost Society, Incorporated.
Mrs E. W. Cope, Christchurch .	.....
Dr C. D. Costello, Hastings .	.....
Mrs H. M. Couper, Havelock North	.....
Mrs W. B. Crowley, Christchurch	.....
Dr W. McG. Cunningham, Dunedin	Head of Department of Periodontology, University of Otago Dental School.
Mr F. J. Darling, Napier .	.....
Mr D. A. Davey, Christchurch .	Christchurch Anti-fluoridation Society.

<i>Witness</i>	<i>Official Position or the Organisation Represented</i>
Dr G. N. Davies, Dunedin .	Head of the Department of Preventive, Public Health and Children's Dentistry, University of Otago Dental School.
Mrs A. M. Deans, Hastings .	.....
Dr H. H. Denham, Christchurch .	Canterbury Division, British Medical Association.
Mr W. H. Doig, Dunedin .	.....
Dr Maud T. Fere, Christchurch .	.....
Mr C. W. Firth, Auckland .	Waterworks Engineer, Auckland City Council.
Mr R. P. Fish, Hastings .	City Engineer, Hastings.
Mr L. R. Franks, Taihape .	.....
Dr W. S. Fyfe, Dunedin .	.....
Colonel J. Ferris Fuller, Wellington	Director of the Dental Services of the Armed Forces of New Zealand, and Member of the Fluoridation Committee of the Department of Health.
Mrs E. B. Gale, Haumoana .	.....
Mr C. E. Gamble, Havelock North	.....
Mr W. L. Garland, Auckland .	.....
Professor Elizabeth Gregory, Dunedin	Dean of the Faculty of Home Science, University of Otago Medical School, and Acting Chairman, Nutrition Research Committee of Medical Research Council of New Zealand.
Mr A. G. Grove, Auckland .	New Zealand Citizens' Vigilance Association.
Mr W. R. Hamilton, Christchurch	Council on Dental Health Education for the New Zealand Dental Association.
Mr J. E. Hanna, Auckland .	.....
Mr J. S. Hannah, Havelock North	The Secretary to the Public Protection Society, Hastings.
Sir Charles Hercus, Dunedin .	Dean, University of Otago Medical School.
Dr Eva E. Hill, Ruakaka .	.....
Mrs A. Hogg, Hastings .	.....
Mr E. W. Hullett, Christchurch .	.....
Mr L. H. James, Wellington .	Assistant Director, Dominion Laboratory, Department of Scientific and Industrial Research.
Madam Mira Louise James, Australia	.....
Mr A. H. Jecks, Christchurch .	Waterworks Engineer, Christchurch City Council.
Mr J. K. Johannesson, Wellington	Chemist to the Wellington City Council.
Mr D. B. Joseph, Auckland .	.....

<i>Witness</i>	<i>Official Position or the Organisation Represented</i>
Mr J. S. K. Kinnear, Auckland .	.....
Mrs M. A. Larsen, Auckland .	Auckland Western Housewives Association, and the National Executive of the Housewives Association of New Zealand.
Mr T. D. Lennie, Christchurch .	.....
Mr H. McD. Lockhead, Hastings	Chairman, Citizens Fluoridation Committee, Hastings.
Mr T. G. Ludwig, Wellington .	Dental Research Officer, Medical Research Council of New Zealand.
Dr P. P. Lynch, Wellington .	Wellington Division of the British Medical Association.
Mr T. H. McCombs, Christchurch	.....
Mrs E. H. M. McInnes, Dunedin	.....
Mr D. B. McIntyre, Auckland .	Representative of the Dr Jensen, 729 Health Club (N.Z.) Incorporated.
Mr C. A. Mackersey, Havelock North	.....
Miss M. McLean, Christchurch	.....
Dr F. S. Maclean, Wellington .	Director, Division of Public Hygiene, Department of Health.
Mr D. P. McLellan, Christchurch	County Engineer, Waimairi County Council.
Dr H. G. McPherson, Hastings .	Hawke's Bay Division, British Medical Association.
Mr G. A. McMillan, Christchurch	.....
Mr J. D. McMillan, Havelock North	.....
Mr P. R. H. Maling, Christchurch	.....
Mr R. S. Malthus, Dunedin .	.....
Dr J. F. P. Mangos, Auckland .	Executive Council, New Zealand Dental Association.
Mr D. B. Mansergh, Auckland .	.....
Mrs I. Marquet, Dunedin .	.....
Mr A. N. S. Moore, Hastings .	.....
Mr J. D. R. Morgan, Dunedin .	Dunedin Junior Chamber of Commerce.
Dr Elizabeth Mudie, Dunedin	.....
Mrs O. Mulinder, Auckland .	Auckland Branch of the Home Science Alumnae Association.
Mr A. W. Mudgway, Hastings .	.....
Dr Effie Neeham, Christchurch .	.....
Mr F. Needham, Taihape .	.....
Dr J. L. Newman, Auckland .	Auckland Division of the British Medical Association.
Mrs E. G. Nichol, Havelock North	.....

<i>Witness</i>	<i>Official Position or the Organisation Represented</i>
Mr J. B. Oliphant, Auckland .	.....
Mr J. S. O'Neill, Dunedin .	.....
Mrs G. I. Paynter, Hastings .	.....
Mr W. A. G. Penlington, Havelock North	Hastings Anti-fluoridation Society.
Dr H. D. Purves, Dunedin .	.....
Mr F. H. Reid, Hastings .	.....
Dr E. B. Reilly, Christchurch .	Canterbury Branch of the New Zealand Dental Association.
Mr D. M. Robinson, Auckland .	Life Member and Past President of the New Zealand Organic Compost Society Incorporated.
Dr E. H. Roche, Auckland .	Auckland Division of the British Medical Association.
Mr M. V. Ross, Auckland .	New Zealand Association of Naturopaths Incorporated.
Mr D. C. Rosser, Auckland .	.....
Mr R. Sarjeant, Riccarton .	Consulting Engineer, borough of Riccarton.
Mr F. Sheffler, Wellington .	.....
Professor F. R. Shroff, Dunedin	Associate Professor of Oral Pathology and Head of the Department of Basic Dental Sciences, University of Otago Dental School.
Mrs D. E. Smith, Christchurch	.....
Mr P. L. Souter, Auckland .	.....
Mr F. W. Stevens, Christchurch	.....
Mr K. C. Stewart, Auckland .	.....
Mrs M. I. Stroobant, Auckland .	New Zealand Citizens' Vigilance Association.
Mr P. F. Swinburn, Auckland .	Auckland Branch of the New Zealand Dental Association.
Mr T. I. Tait, Hastings .	Hastings Junior Chamber of Commerce.
Dr C. N. D. Taylor, Palmerston North	Medical Officer of Health, Palmerston North Health District (which includes Hastings city).
Mr J. McC. Tocker, Christchurch	Canterbury Junior Chamber of Commerce.
Mr M. L. Tronson, Auckland .	Auckland Junior Chamber of Commerce, and the North Shore Junior Chamber of Commerce.
Dr H. B. Turbott, Wellington .	Deputy Director-General, Department of Health.
Mrs D. P. Van Asch, Hastings .	.....
Mr E. G. Vogtherr, Napier	.....
Professor J. P. Walsh, Dunedin .	Dean and Director, University of Otago Dental School.
Professor J. Le B. Warren, Dunedin	Professor of Conservative Dentistry, University of Otago Dental School.
Mr G. J. Watson, Christchurch .	.....

<i>Witness</i>	<i>Official Position or the Organisation Represented</i>
Dr D. G. Watt, Wellington .	Wellington Branch, New Zealand Dental Association.
Mr E. R. Whyte, Hastings .	Hawke's Bay Branch, New Zealand Dental Association.
Mr J. Francon Williams, Wellington .	Assistant Director, Division of Dental Hygiene, Department of Health.
Dr U. G. Williams, Wanganui .	.....
Mr R. B. Cape Williamson, Christchurch .	.....
Mr H. H. Wylie, Hastings .	.....

APPENDIX E

(i) Record of Evidence, Volumes I to X, at public hearings including Letters and Statements Admitted by Consent thereat.

(ii) List of persons who made submissions by letter subsequent to the last public hearing at Wellington. They are inserted in Volume X (*supra*).

<i>Writer</i>	<i>Date of Correspondence</i>	<i>Summary</i>
Mr R. M. Daniell ..	2 May	Submission.
Mr J. B. Eatwell ..	11 June and 7 July	Submissions.
Dr Eva E. Hill ..	22 April and 23 June	Further submissions.
Mrs E. B. Gale ..	27 May	Agreement to confidential inquiry as to analysis of blood specimen. (Letter retained by Chairman of Commission.)
	12 June	Offer to forward the book <i>The Drama of Fluorine</i> , by Dr Leo Spira.
Mr D. R. Masefield	18 May	Submission.
The Hon. G. R. Mason, Q.C.	21 May	Submission.
Dr D. S. Milne ..	19 June	Certificate regarding analysis of blood specimen of citizen alleged to have suffered effects from drinking Hastings water. (Certificate retained by Chairman of Commission.)
Mr W. A. G. Penlington	20 (two), 29 April 14, 18, 24 May 17 June 3 July	Further submissions.
Mr J. L. Scott ..	6 June	Submission – being extract from <i>The Christian Science Monitor</i> of 1 March 1957.
The Secretary, Taranaki Fluoride Inquiry Group	7 May	Submission.
Mrs A. Wilkinson ..	30 June	Submission – being the leaflet <i>Further Facts on Fluoridation</i> .
Dr U. G. Williams ..	24 May	Further submission.
Mr R. Young ..	13 June	Submission – being booklet <i>Science News</i> , No. 38.

APPENDIX F

Extract from *Hawke's Bay Herald-Tribune* of Friday, 16 March 1951

HASTINGS SUGGESTED AS CENTRE FOR DENTAL CARIES EXPERIMENT

Hastings may become the centre of an experiment – the first of its kind – into the prevention of dental caries by the inclusion in the town water supply of the correct proportions of sodium fluoride. A suggestion along these lines made to the Hastings Borough Council last night by a representative of Hastings members of the New Zealand Dental Association was favourably received by the council.

It was explained to the council that sodium fluoride had been the subject of a considerable amount of experimentation into dental caries in America for about 10 years and in England for 7 or 8 years, and it had been proved that the inclusion of an appropriate amount of fluoride in the drinking water would lessen the incidence of dental decay. Results in the two countries had been similar. After the consumption of water in the community with the correct amount of fluoride the incidence of caries in 33 months had been reduced by 28 per cent and in 44 months by 40 per cent.

If the incidence of dental caries in Hastings could be reduced by 40 per cent, the cost of treatment to the people would be lowered by that amount. There was 0.15 parts per million of fluoride in the water now, but the desirable quantity was 0.8 to the part per million. If any valuable information was to be deducted from such an experiment it was necessary to have a control town nearby and, for that reason Hastings had been selected with Napier as the control town where fluoride could not be injected into the water.

If the use of fluoride was of value to the community, in that it would lessen the payout by the Government through its dental social services, then it was felt the State had a reasonable financial responsibility. It was difficult to assess the costs, but it was possible the plant necessary to introduce the fluoride into the water might cost about £1,000, and the cost of the fluoride supply might be 6d. per head of population per annum.

If the council gave tentative approval to such a scheme, then the subject could be raised immediately after Easter with the Minister of Health with a suggestion that the Government might meet the whole or at least a big portion of the cost.

The Mayor, Mr R. D. Brown, gave the dental surgeon an assurance that the council was sympathetic. If it was to be of benefit to the public health, then the scheme was something in which the council should interest itself.

The council decided that, after the dental surgeon had had his talks with the Minister of Health, it would be prepared favourably to consider the proposal.

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 (2) Charts and tables referred to appear as Appendix B.

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