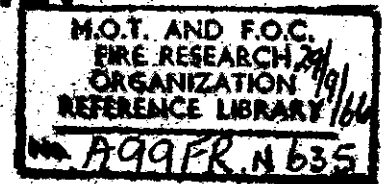


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Fire Research Note

No. 635



THE SITING OF FIRE STATIONS IN BRISTOL

by

JANE M. HOGG.

FIRE  
RESEARCH  
STATION

**Fire Research Station,  
Borehamwood,  
Herts.  
ELStree 1341**

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MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE  
JOINT FIRE RESEARCH ORGANIZATION

# THE SITING OF FIRE STATIONS IN BRISTOL

by

Jane M. Hogg

## Introduction

Rapid spread of fire endangers life and surrounding property. Once a fire has a hold damage can become extensive unless it is speedily tackled by experienced firefighters.

The local authority fire brigades are adept at exceptionally rapid turnouts, but the time it takes to get to a fire is necessarily dependent upon the distance to be travelled, and upon the conditions experienced during the journey. The time that elapses between the brigade receiving the alarm and its arrival at the incident is directly affected by the location of the fire station.

Selecting the optimum number of fire stations and their best position in relation to each other will minimize the total loss from fire. The area to be served by each fire station must be taken into consideration, and this will depend upon the number of stations and will change as their number and location alters.

## Fire cover regulations

The Home Office Fire Service Department in 1947 drew up a set of recommended standards for the attendance of pumps to fires.\* For example, 'in a congested urban centre with important risks' the number of pumps sent on 'the first attendance' should be 3 or 4; and the 'approximate time limits for attendance' for the first pump should be 5 minutes; and in 'the mainly rural areas with scattered villages and hamlets and isolated homesteads' the respective suggested standard is a first attendance of one pump to arrive within the 'approximate time limit' of 20 minutes.

The siting of fire stations, and the number required in any brigade area will, therefore, have been largely determined by these Home Office Fire Service standards of fire cover.

## Station sites in Bristol

Bristol County Borough and some surrounding areas of Gloucestershire and Somerset have been served by six stations since 1948 on the disbanding of the National Fire Service. The region covered (see map) has, therefore, been divided into six station areas, each served by the station within its boundaries, but relying on the nearest stations for reinforcements.

During the period from 1947 to 1966 siting changes have been made. In 5 of the 6 areas a new station has been built on another site, and has replaced the existing station. The central area, which is served by the Brigade Headquarters, has not so far had a change of site, but a new building has been planned.

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\*Confirmed with minor alterations in 1958.

Of the 5 stations which have been replaced, 4 of the buildings are still available if required. In addition to the site for the proposed new Headquarters the Chief Fire Officer can possibly obtain 8 further sites for building fire stations.

This total of 19 sites is shown in Fig. 1. together with the pattern of fire incidence (discussed below). Station 1 is the proposed new headquarters; stations 2, 3, 4, 5, 6, and 7 are the six stations serving the Bristol area at the present time, (although it is expected that station 7 will be replaced by station 1 in the near future); stations 8, 9, 10 and 11 are those old stations which were replaced by stations 3, 4, 5, and 6 respectively; and sites 12 to 19 are those which may be available to the Chief Fire Officer if he should require them.

Not all of the nineteen sites are the same size and the maximum number of bays available per station (which will determine the number of appliances covering that station's area) varies from 2 at station 9 to 9 at station 1.

The number of appliances required to be out fighting fires simultaneously depends upon the nature of the area they serve. Road accidents, flooding incidents, rescue operations, all known as special services, also affect the demand for fire appliances at any time. On one occasion in recent years no less than 13 of Bristol's appliances and 58 of its men were in attendance at 4 different incidents, 3 of which (involving 12 of the appliances) were located within one square mile.

#### Location of fires

Although it is not possible to predict when or where the next fire will occur, it is possible to forecast the largest number of appliances which might be required in any part of the country at any time of the day during the coming year.

The pattern of fire incidence is known to change very slowly, and in Bristol did not alter during the period 1958 to 1964, even though new estates were being built. Fig. 1 indicates the severity of fire incidence per square kilometre experienced by Bristol.

Fires occur most often in the places where human activity is greatest, so that the denser the population the more frequent becomes the incidence of fire.

Fires occur more readily in industrial and commercial districts than in residential areas. They also tend to become larger. The maximum number of appliances that will be required to fight fires, at one and the same time, in this kind of district will therefore be much larger than will be the case in residential areas.

#### Criteria for optimum siting of fire stations

The optimum siting of a given number of stations is at those points from which any deviation would show an increase in the total spread of all fires. The spread of fire cannot, however, be measured in terms of pounds, shillings and pence, as the data are not as yet available to this Organization. The minimum total time spent by all appliances journeying to fires has therefore been used as the criterion for optimization.

Since a district with a very high fire spread risk will in any case require a large number of appliances because of its numerous and more serious fires the lack of economic data is not as serious as might be feared.

Nevertheless, it is important to know the monetary loss from fire since without this knowledge the local authority has some difficulty in arriving at the optimum number of stations to have within its boundaries. Every additional station should pay for its upkeep in terms of the resultant saving in life and monetary loss of fire, the optimum number of stations being that number beyond which any additional station would not be paying for itself.

#### Method\*

The solutions arrived at have been obtained by selecting, from the sites available, those which would have given the minimum overall journey time of all the appliances attending fires which occurred during the period 1958 to 1964. As the pattern of fire incidence changes very slowly the solutions will be valid for many subsequent years.

The availability of appliances was taken into account, allowances being made for the number of appliances which could be housed at the nearest stations and for the number already in use at fires and other incidents.

No allowance was made for the effect of different attendance times on the size of the fires, but this deficiency is being remedied.

#### Choice of stations in Bristol

Since the optimum number of stations cannot as yet be arrived at, the best sites for alternative numbers of stations in Bristol are given in Table 1.

Table 1: Optimum sites for minimizing total journey times to fires in the Bristol area

Number of Stations	Best sites
1	7
2	7, 16
3	7, 16, 3
4	7, 16, 3, 5
5	7, 16, 3, 5, 2
6	7, 16, 3, 5, 2, 17
7	7, 16, 3, 5, 2, 17, 9
8	7, 16, 3, 5, 2, 17, 9, 19
9	7, 16, 3, 5, 2, 17, 9, 19, 8

\*(A detailed account of the methods used will be published elsewhere)

If Bristol were to be served by only one station the best station would be station 7, which is the present Headquarters of Bristol Fire Brigade. With only one station, however, Bristol could not provide cover to the area without considerable assistance from other local authorities.

Served by the best three stations, 7, 16 and 3 (in that order) Bristol would be virtually self-sufficient, but attendance times would be unsatisfactory.

The best six sites are not the sites of the present operating stations, but are sites 7, 16, 3, 5, 2 and 17. Site 16 is preferred to station 6 and only one station has been picked to serve Bristol south of the river Avon. The fire risk in the centre of Bristol is so high that total journey times are minimised by siting two stations in the centre and one south of the river, rather than by having one central station and two south of the river, as in the current alignment.

The recommended alignment would not, however, satisfy the Fire Service regulations mentioned above. The first pump would fail to reach the new industrial estate within the hinterland of station 4 inside the recommended time limit of 5 minutes.

The ideal site south of the river, in any case, is not station 5 but lies at the junction of St. John's Lane and Littleton Road. This is the point which minimises all journey times in the area, and is some 5 minutes away from the new industrial estate mentioned above.

In order to satisfy the Fire Service regulations on fire cover, and achieve the optimum alignment of available station sites (using the criterion of minimum total journey times) it would be necessary for the Bristol area to be served by 7 stations. The six sites chosen as the best six plus site 9 is the choice for the best seven. There would then be two stations south of the river, and the Fire Service regulations would be adhered to.

It is not, of course, known whether the addition of station 9 would have the result of reducing the monetary fire loss in Bristol sufficiently to offset the cost of adding the seventh station.

It is interesting to note that the solution for the best choice for 9 stations in Bristol includes an additional station in the potentially dangerous Avonmouth dock area; station 8 being chosen in addition to station 3 for that area, suggesting a need for 8 bays instead of 6.

## Conclusion

The results for Bristol have been evolved using computer programs to elicit optima in terms of minimum journey times to fires. The method of analysis used to arrive at these conclusions can be at once applied to the solution of similar problems in other brigade areas. Moreover it can solve associated problems such as forecasting future manpower requirements.

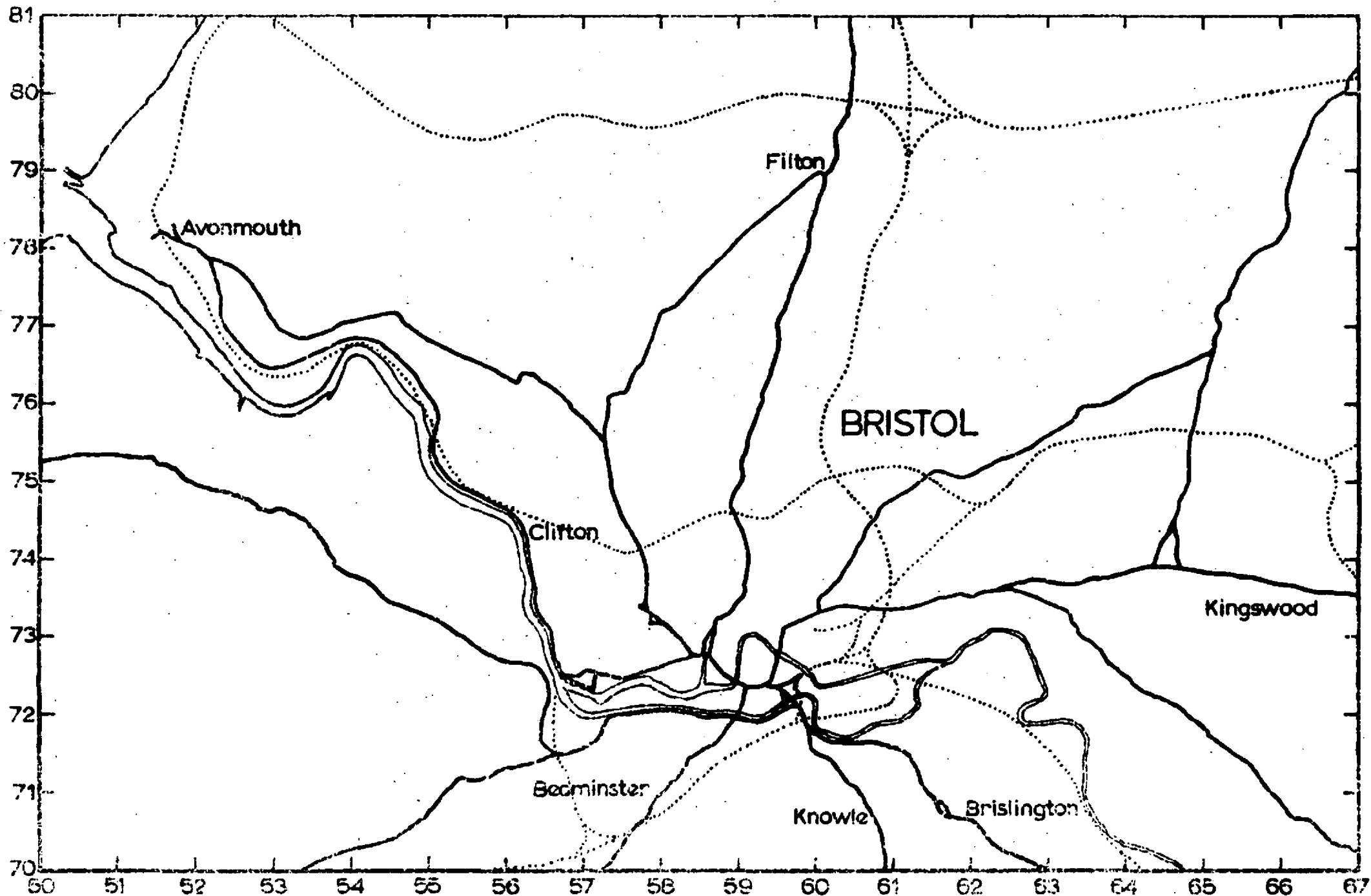
A more sophisticated set of methods is now under development to bring into the analysis the more meaningful economic criteria. It will then be interesting to compare the results arrived at for optimum station siting in Bristol with those presented here.

### Acknowledgements

The co-operation of Bristol Fire Brigade and, in particular, Chief Fire Officer Holland and Divisional Officer Ponsford, has been invaluable.

The Atlas Computer Service, and Mr. Chandler of the Joint Fire Research Organization must also be thanked for their part in the successful completion of this exercise.





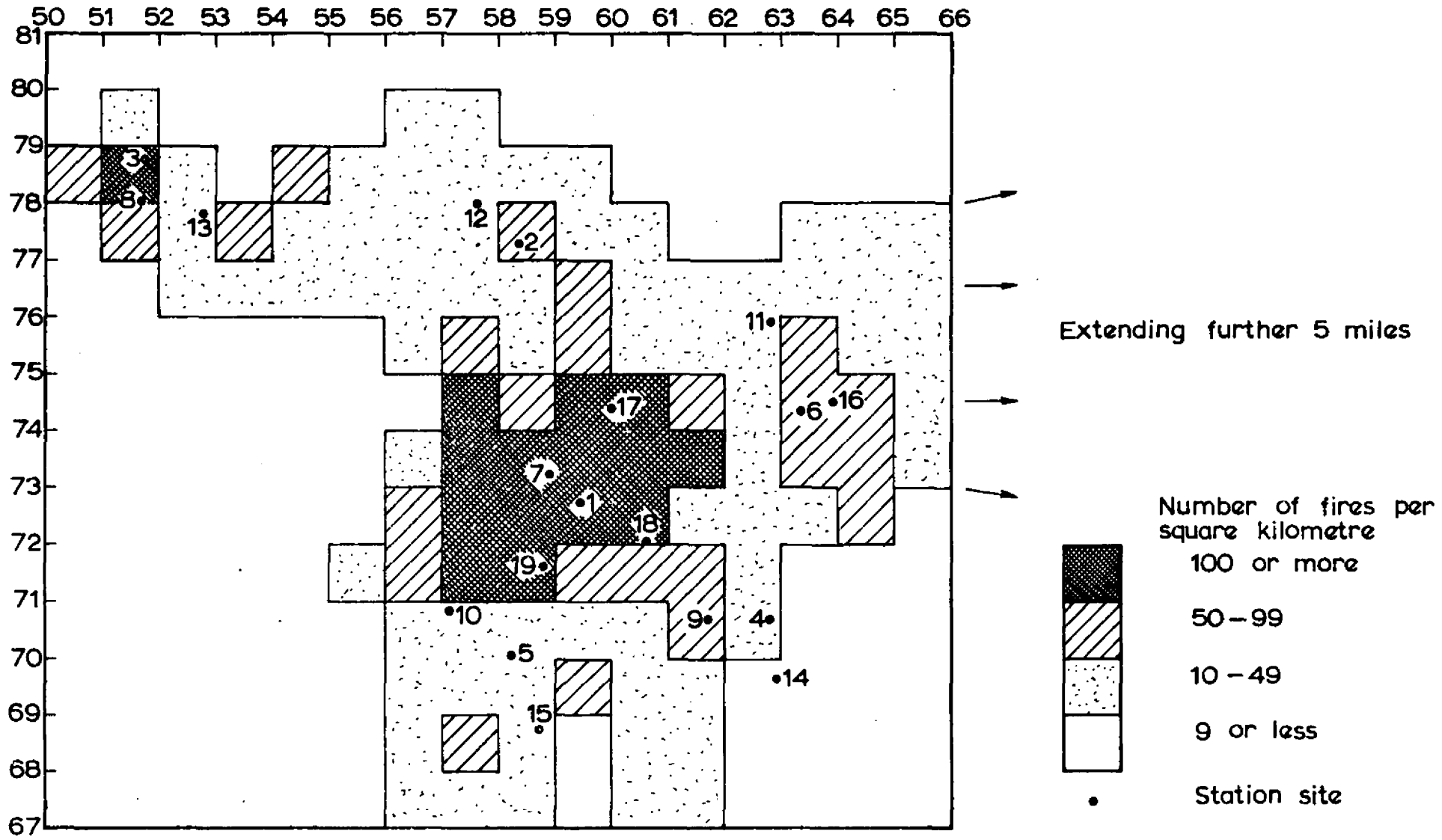


FIG.1. LOCATION OF FIRES IN BRISTOL FOR THE PERIOD 1958-1964 INCLUSIVE (i.e. fires other than late calls and those confined to chimneys and grassland)

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