Division of Forest Products - Reprint No. 88.

[Preprint from the Journal of the Council for Scientific and Industrial Research, Vol. 18, No. 1. February, 1945.]

A Survey of Houses Affected in the Beaumaris Fire, January 14, 1944.

*By G. J. Barrow.**

Summary.

To determine the influence of the type and details of construction on the resistance of houses to external fire hazards, a survey was made of the damage caused by the fires which swept the bayside resort of Beaumaris, Victoria, on January 14, 1944. General observations on the 66 houses destroyed or damaged and a detailed study of seventeen representative houses showed that the resistance to fire is determined more bv the details of construction than by the materials used in the walls. Although the damage was caused primarily by the external fire, practically all the houses ignited inside, i.e. in the roof space, in rooms, or under the floors, due to the ingress of flame, sparks, and embers through openings such as ventilators, eaves, and windows. Sealing or screening such openings by fine wire mesh greatly reduced the risk of damage, and the conclusion was drawn that, from the point of view of resistance to external fires, a house should be as air-tight as practicable and that any openings which cannot be eliminated should be screened. A list of recommendations, the adoption of which should do much to reduce the fire risk, is included.

1. Introduction.

On January 14, 1944, one of the worst conflagrations in the history of the metropolitan area of Melbourne, swept through the bayside resort of Beaumaris. Beaumaris is situated on the eastern coast of Port Phillip Bay, 12 miles *(19 km)* from Melbourne; some twenty years ago it featured in a closer settlement scheme and an electric tramway service was extended from Black Rock. The scheme was abandoned and the tramway system, after operating for a period of five years from 1926 to 1931, was discontinued and subsequently dismantled. Since that date there have been no improvements made in the area, which, although subdivided in detail has been allowed to return to its natural state. The dwellings in the area are of two main types -

(i) Small four- or five-room houses of varying construction, built as seaside dwellings either at the time of the settlement scheme or since;
because of the housing shortage most of them are now permanently occupied.

(ii) Large homes constructed either by the early settlers or, in recent years, by residents who are not dependent on public transport.

The fire destroyed 58 houses and damaged eight others, and advantage was taken of the opportunity to obtain general data on the fire hazard in semi-rural areas and to determine the influence of the type and details of construction on the resistance of houses to external fire hazards.

---

* An officer of the Division of Forest Products.

C.12539/44.

Approximately 100 houses were inspected during the week following the fire, and from these seventeen were selected as being representative of the general damage and conditions. A detailed study of these particular houses was then made.

The number of persons interviewed who were actively involved in the fire (either owners, occupiers, or service personnel) was approximately 200, and from these eyewitnesses data were collected on matters relating to houses destroyed, damaged, or saved.

The gathering of the data for the report was greatly facilitated by the willing co-operation of the following: - Police officers at Mentone, Black Rock and Cheltenham; the Town Clerk of the Sandringham City Council; the superintendent, staff, and linesmen of the Cheltenham District Depot of the State Electricity Commission; the district officer of the Melbourne and Metropolitan Fire Brigade; auxiliary and volunteer firefighters; owners, occupiers, and agents of the damaged properties.

2. Location of the Fire.

The fire occurred within an area of some 1,500 acres *(600 hectares)*, bounded on the north by Bay Road, Cheltenham,.the west by Reserve-road, the south by the sea, and on- the east by Charman-road; Mentone and Cheltenham, as shown in Map 1. The area, north of Weatherall-road is included in Map 1 because, although there is little damage in this area, it is believed that the main fires through the Beaumaris area originated there**.** Of the 1,500 acres *(600 hectares)* included in the map some 700 *(280 hectares)* were burnt.

The main fire area south of Balcombe-road was mainly dense scrub land covered by a heavv growth of tea-tree *(Leptospermum lævigatum* and *L. coriaceum* mixed) with scattered groups of manna gum *(Eucalyptus viminalis)* and coast acacia *(Acacia sophoræ)*, and with groups of white sallow acacia *(Acacia floribunda)* further back from the coast; throughout this area were scattered clearings of from 1 to 5 acres (0.4 to 2 hectares) densely covered with dry grass and bracken *(Pteridium aquilinum)* often to a height of 3 feet *(900 mm)*; in the lower swamp areas were several acres of swamp tea-tree *(Melaleuca squarrosa).* The houses destroyed and damaged extended throughout this area but were mainly situated within three-quarters of a mile *(1.2 km)* from the sea.

In attempting to retain the locality in its natural state, the majority of the residents had allowed their properties to become thickly wooded with native trees and shrubs, augmenting the natural growth in many cases with exotic vegetation, thus forming a dense thicket to within 40 to 20 feet *(12 to 6 m)* of their dwellings, and in many cases in contact with them.

Scrub fires in this area have been a common occurrence for many years, but are usually localized and are fairly easily checked before constituting a menace to the populated sections of the district. The origins and progress of the fire, as observed by officers of the State Electricity Commission, are shown in Map 1. It will be noted that there were two distinct fires: the first swept over the eastern portion of the burnt area, and the second, which occurred half an hour to an hour later, burnt the western portion, overlapping to some extent the area covered by the first fire. Both fires burnt down to the water's edge.

As will be seen from Map 2, the fire burnt over both scrub land and grass land, but was very much fiercer and presented a much greater hazard to houses in the scrub land. In the grassed areas, it was comparatively easily controlled by breaks such as roads and cultivated areas and by spraying with garden hoses.

The fares were fought by personnel of the Metropolitan Fire Brigade, State Electricity Commission, Police Department, Civil Defence Organizations, Army, and local residents and volunteers with fire hoses, garden hoses, and, where the water supply failed, with beaters. As a result of their efforts, a number of buildings which were apparently doomed were either saved or only slightly damaged.

About 208 houses in the area were in some danger, but 90 of these, located in cleared areas or in grass lands, even though in some cases completely surrounded by fire, were not in immediate danger, as the fire was controllable and was deflected away from the houses by the fire fighters. The remaining 118 houses were gravely threatened because of actual contact with flames or burning debris.

3. Conditions Leading up to the Fire.

Meteorological data for the day of the fire, together with the weather conditions for the preceding six months, as supplied by the Commonwealth Meteorological Services, Department of Air, Melbourne, are given in the Appendix.

Conditions prior to and during the fire were ideal for a major conflagration. The six months preceding the fire were abnormally dry and several perennial species of small flora (particularly sundews and orchids), for which this and surrounding districts are noted, bad failed to appear. The day of the fire was hot with a strong dry northerly wind, the maximum shade temperature being 103.2°F. *(39.6°C)* and the maximum wind velocity being 54 m.p.h. *(86 km/h)*, the relative humidity falling to 6 per cent., corresponding to an equilibrium moisture content in wood of about 2 per cent.

4. Extent of Damage and Location of Buildings.

The location of the houses in the affected area, together with information on the type of construction and the extent of the damage (if any), is given in Map 2.

For convenience in locating the seventeen houses selected for detailed study, Map 2 has been divided into sections A, B, C. Sections A and B have each been subdivided into three subsections.

The extent of the damage in relation to the type of and number of houses seriously threatened by the fire is given in Table 1. It may appear from this table that the brick and concrete houses were less liable to danger than timber frame houses with fibro-cement or ash-cement rendered walls. However, statistical investigation has shown that there are no significant differences in the percentages of different types of houses destroyed or damaged.

Table 1. - Number of Affected Houses in Relation to Type of Construction and Number Seriously Threatened.

Construction	Number Seriously Threatened	Number Affected.			Percentage Affected.		
		Destroyed.	Damaged.	Total.	Destroyed.	Damaged.	Total.
W: W/B	83	41	5	46	50	5	55*
CS/W: CS: ACL/W	15	8	2	10	53	13	66*
B: V: C	20	9	1	10	45	5	50*
Total	118	58	8	66			

Notes.- 1. An additional 57 properties sustained damage to outhouses and fences only.

2. Statistical examination has shown that there is no significant difference between the percentages marked thus*.

LEGEND.-

W - weatherboard.

W/B - weatherboard with brick foundation

CS/W - timber frame with weatherboards to 3-4 feet *(0.9-1.2 m)* from ground and fibro-cement sheets above.

CS - fibro-cement sheet over timber framework.

ACL/W - timber frame with weatherboards to 3-4 feet *(0.9-1.2 m)* from ground.

B - brick and brick stucco covered.

V - brick veneer

C - concrete block or slab

It must also be noted that the brick, brick veneer, and concrete houses were in general located somewhat more favourably than the others, in that they were generally surrounded by well-kept gardens, which tended to lessen the severity of the attack. Brick houses which were completely gutted, leaving the walls only standing, have been considered as being destroyed in compiling the Table (see Plate 1, Fig. 1). Further details of the extent of the damage in relation to the type of construction and location of the houses are given in Table 2.

5. Observations.

Points of particular interest are illustrated by the photographs which, with the accompanying captions, are self-explanatory.

Detailed records of the construction, surroundings, point of ignition and extent of the damage to the seventeen representative houses mentioned previously have been filed and are available to any one interested, but the following observations should be of general interest.

The use of ½-in. *(12 mm)* mesh wire netting as a guard against birds, rodents, and possums proved to be of great value in preventing burning debris from being carried by draughts through wall ventilators, louvre openings, and under floor air-vents (see Plate 5, Fig. 1).

Table 2.—House construction and extent of damage in each section.

Section.	Construction.		Destroyed.	Damaged.	Outhouses, Fences Damaged.	Undamaged.
A1	Scrub and fence damage only		. .	. .	. .	. .
A2	W	Corrugated iron roof	6	1	8	1
	W	Tile roof	2	. .	3	. .
	CS/W	Corrugated iron roof	2	. .	1	. .
	CS	Fibro-cement roof	1	. .	1	. .
	B	Corrugated iron roof	. .	. .	. .	1
A3	W	Corrugated iron roof	12	. .	6	7
	W/B	Corrugated iron roof	1	. .	. .	. .
	W	Tile roof	4	1	. .	4
	CS/W	Corrugated iron roof	. .	. .	. .	3
	B:V	Tile roof	2	1	1	2
	C	Corrugated iron roof	1	. .	1	. .
B1	W	Corrugated iron roof	2	1	1	1
	W	Tile roof	. .	. .	. .	1
	ACL/W	Corrugated iron roof	. .	. .	. .	1
B2	W	Corrugated iron roof	4	. .	8	5
	W	Tile roof	1	. .	3	3
	CS/W	Corrugated iron roof	. .	. .	1	3

	ACL/W	Corrugated iron roof	1	. .	. .	1
	B	Corrugated iron roof	. .	. .	. .	1
	B	Tile roof	. .	. .	2	5
B3	W	Corrugated iron roof	3	1	8	3
	W	Zinc-anneal roof	. .	. .	. .	1
	W	Tile roof	3	. .	3	4
	WCS	Tile roof	1	. .	1	. .
	ACL/W	Tile roof	1	. .	. .	. .
	B	Zinc-anneal roof	. .	. .	1	. .
	B	Tile roof	5	. .	4	7
	V	Tile roof	. .	. .	4	. .
C1	W	Corrugated iron roof	2	1	5	20
	W	Tile roof	1	. .	4	14
	W/B	Tile roof	1	. .	. .	. .
	CS/W	Corrugated iron roof	1	1	. .	4
	CS	Fibro-cement roof	1	. .	1	1
	CS	Corrugated iron roof	. .	1	. .	2
	CS	Tile roof	. .	. .	1	. .
	B	Tile roof	. .	. .	2	9
	B	Corrugated iron roof	. .	. .	1	7

The fire burnt the fences of fourteen houses but was stopped before it could constitute a menace to the houses, which were situated either

in cleared areas or in grassland.

Flywire proved in a number of cases to be an excellent spark arrester, House B3-6 being a case in point. This dwelling had large openings across the front covered by fly-wire; immediately behind the wire were large canvas blinds which were down during the whole period of the surrounding fire. A. general profusion of sparks and burning material was swept against this portion of the house, but an examination of the framing ledge between the fly-wire and the blinds showed it to be free of any charred material or ash.

Both hessian and canvas showed little resistance to sparks, hessian bags lying in yards and canvas blinds up to a distance of a mile *(1.6 km)* from the fires being burnt.

Wall ventilators and air vents below floor level, where unprotected by some form of screening. proved disastrous in a number of cases. In some cases where the fire appeared to be controlled a sudden draught swept sparks up to the dwelling and in through these vents. This point was well illustrated in the fighting of the fire at House B2-1. While a fire was being fought in the eaves and ceiling at the rear of the house, the draught through the underfloor vents near, the ground at the back of the house swept burning material under the house to such an extent that a fire under the floor became uncontrollable. A similar type of attack occurred at Houses B3-9, C1-1, and C1-3.

> Houses with eaves either boxed with fibro-cement sheets or completely boarded had a greater degree of safety than those with eaves left open for ventilation. It was reported that the majority of fires started in the roofs.
>
> Fibro-cement sheets were found to be fire retardant but not fire proof; when subjected to intense heat they cracked, flaked, and collapsed. Where water could be poured or sprayed to keep them cool they proved a most effective check to the spread of fire. This point is shown in Plate 2, Fig. 2, the fibro-cement sheets are still intact above the steel door of the garage. The fire within the garage was so fierce that the front of the garage was sprayed with a fire hose for more than fifteen minutes before the fire behind the door burnt out.
>
> Several fires became uncontrollable because shingles on the gable ends of the buildings ignited and the draught swept the flames into the roof through large roof ventilators. It would be preferable to replace these by a number of small ventilators, as shown in Plate 6, Fig. 1.
>
> Badly fitting Marseilles pattern tile roofs were a source of danger; houses which either had a reasonably good chance of escaping the fire or were considered to be saved as the fire had passed, were either damaged or destroyed through the access of sparks and small burning debris under the tiles.
>
> There were several cases of roof fires in houses roofed with corrugated iron; generally these fires entered through large roof ventilators in gable ends or ignited the protruding eaves and burnt through to the rafters and ceiling joists. The position of the guttering prevented the updraught from carrying the sparks up under the corrugations into the roof, however it is a possibility that in some cases an accumulation of burning debris, lodged in the guttering, may have been swept under corrugations by an eddy of wind.

Compared with that of sealing a tile roof with its multiple openings there is little difficulty in sealing a corrugated iron or corrugated fibro-cement roof. This can be done by scalloping the fascia board to fit the corrugations, by nailing a scalloped sheet of iron to the fascia, or filling the spaces under the corrugations with fibro-cement or mortar.

Throughout the fire several houses were seen to ignite although there was no apparent contact with the flame, sparks, or burning debris; this ignition took place both in the roofs and in the walls.

In a number of cases the proximity of high trees, preceded by very low scrub or grass, proved an effective fire break. This applied only in cases where branches of the trees were not located under the eaves. Due to the hurdling effect of the high trees the draught caused by the fires swept the burning material over the house. In the majority of cases the trees either failed to ignite or burnt slowly and so proved controllable (Fig. 1 and Plate 6, Fig. 2). It must be emphasized that high trees gave protection only when surrounded by grasslands or by low scattered scrub.

In the case of unattended houses (where fire fighting was impossible) the normal time from ignition to destruction was seven to fifteen minutes for brick or brick veneer and ten to 25 minutes for timber frame houses.

Evidence obtained during the survey indicates that there is no possibility of predicting the behaviour of a scrub fire. In a number of cases, scrub and trees which appeared to be burnt out, re-ignited, accompanied by a crackling and hissing noise suggestive of gas igniting; these flashes of fire would then jump distances up to several hundred feet hundred feet *(100 or more metres)* igniting any scrub through which they passed. The rush of flame and the intense heat of the burning tea-tree caused many unexpected draughts and caused runs of fire to burn back against the wind for several hundred yards *(metres)*.

This process of the fire chopping about in several directions was instrumental in saving some houses by first burning breaks either near or partially around them. This occurred in the case of House B3-1 where a fire burnt off the scrub to the front, the east and a section of the trees to the south (rear) of the house, thus leaving only one side and a corner to be protected when the second fire came through from the north-west. Inspection of this dwelling after the fire gives the impression that it was completely surrounded by fire. This was quite correct, but the fire was not burning on all sides at the same time.

6. Conclusions.

The survey showed that, in a fire of the type that swept Beaumaris, the chances of a house surviving are determined more by the nature of the surroundings and the details of construction than by the materials used in the walls. With two exceptions, all the really destructive fires started inside the houses, i.e., in the roof space, in rooms, or under the floors, the immediate cause of ignition in such cases being the entrance of flame, sparks, and burning-debris through openings such as ventilators, eaves, and windows. An air-tight house would appear to have much greater resistance to fire than one in which free circulation of air is encouraged. Of course, an air-tight house, even if it could be built, would be most undesirable for other reasons, but it is necessary in areas such as Beaumaris, where a serious fire hazard exists, to make a compromise between fire resistance and ventilation, by completely boxing the eaves, sealing roofs, &c.

In the two exceptions referred to previously, the houses appeared to ignite externally due to the high temperature of the surrounding scrub fires. However, these observations may not be correct, as under conditions such as existed at the time, observers' reports are often unreliable, and it is quite possible that these houses also caught alight because of the entrance of flame and sparks.

Experience at Beaumaris showed that the ill effects of openings can be considerably mitigated by covering them with ½-in. mesh *(12 mm)* wire netting or preferably with fly-wire. The wire netting will prevent the entrance of burning debris, and fly-wire is effective in stopping sparks These coverings, in a number of cases, saved houses from destruction. Similarly, fly-wire window-screens and doors are of great assistance in preventing the entrance of sparks in the event of windows or doors being accidentally left open during the fire.

Badly fitting Marseilles pattern tile roofs appear to be a menace as they provide innumerable openings through which sparks may enter. Some form of sheet roofing, e.g. corrugated iron, fibro-cement, or close fitting composition roofing, appears to be much more satisfactory. Corrugated roofing should be sealed at the eaves, ridge, hips, and valley by some such composition as mortar or fibro-cement.

These simple precautions greatly increase the resistance of a house to fire, with little, if any increase in cost, and they are likely to be far more effective than such methods of protection as the use of non-combustible materials for walls. The impression gained from a glance at a completely gutted brick house in which the walls are still standing (see Plate 1, Figs. 1 and 2), is that the damage is much less serious han in the case of a timber frame house which is usually burnt to the ground. However a little consideration will show that the cost of the walls of a timber frame house is a comparatively small proportion of the total cost, and the cost of reconditioning a burnt-out brick house is likely to exceed the cost of rebuilding a timber frame house.

7. Recommendations.

The adoption of the following recommendations in areas where there is a fire hazard, would do much to reduce the risk: -

1.. In timber houses, the walls below floor level should be close boarded, ventilation being provided by woven wire vents.

2. All vents should be of the woven wire type or else covered by a fine mesh.

3. Large ventilators in gable ends should be eliminated and replaced by a number of scattered small ventilators with fine mesh openings.

4. Eaves should preferably be completely boxed, but if left open should be covered by fine mesh wire netting.

5. Badly fitting Marseilles pattern tiles are a source of danger.

6. The space under the corrugations of corrugated roofing should be closed at the eaves, ridges, hips, and valleys.

7. Fly-wire window-screi6na and doors are beneficial.

8. Trees and shrubs should be kept clear of the walls.

9. Stacks of fuel should be well clear of the walls or stored in properly constructed sheds.

APPENDIX

Weather conditions in Melbourne

(Compiled from data supplied by the Commonwealth Meteorological Services, Department of Air, Melbourne.)

Note: The S.I. Units of measurement shown were derived from the Imperial values in the original version of the Report.

(1) CONDITIONS FOR SIX MONTHS ENDING JANUARY 31, 1944

Month.	Mean Temperature (°C)	Rainfall (mm)

	Temperature.	Normal.	Rainfall.	Normal.
August	8.8	10.6	24.1	48.0
September	11.7	12.3	50.5	57.9
October	13.8	14.3	21.3	66.5
November	15.7	16.3	79.2	57.7
December	17.6	18.3	17.3	58.2
January	20.3	19.7	18.8	49.0
Total			**211.2**	**337.3**

(2) CONDITIONS FROM JANUARY 1 TO JANUARY 14, 1944

Date, 1944	Maximum Temperature (°C)	Maximum Wind Velocity (km/h)	Wind Direction (Prevailing)	Rainfall (mm)
January 1	38.1	40	NNE	nil
2	26.6	37	WSW	1.3
3	23.6	37	NNW	nil
4	20.4	42	SSW	0.5
5	20.7	37	WSW	4.1
6	22.7	23	SSW	0.3
7	28.9	26	SSE	nil
8	38.9	41	NNE	nil
9	23.6	29	S	nil
10	26.9	40	NSW	nil
11	21.1	26	W	nil
12	21.0	29	ESE	nil
13	33.1	18	WNW	nil
14	39.6	54	N	nil

(3) CONDITIONS ON JANUARY 14, 1944

Times.		Condition.				
Local Mean.	Australian Eastern Daylight Saving.	Wind Velocity (Average). [km/h]	Wind Direction.	Temperature [°C]	Relative Humidity. [%]	Equilibrium Moisture Content. [%]
7	8:20	35	N	26.9	25	5.0
8	9:20	35	NNE	29.5	24	5.0
9	10:20	42	N	31.2	17	3.5
10	11:20	45	N	32.8	13	3.0
11	12:20	42	N	34.2	12	3.0
12	1:20	39	N	36.2	10	2.5
13	2:20	35	N	37.6	7	2.5
14	3:20	37	NNW	38.4	9	2.5
15	4:20	32	N	**39.6**	9	2.5
16	5:20	26	N	38.4	8	2.5
17	6:20	26	NNW	38.4	6	2.0

(a) Maximum temperature at Melbourne (19 km NNW of Beaumaris) on January 14, 1944, was 39.6°C occurring at 1455 L.M.T.

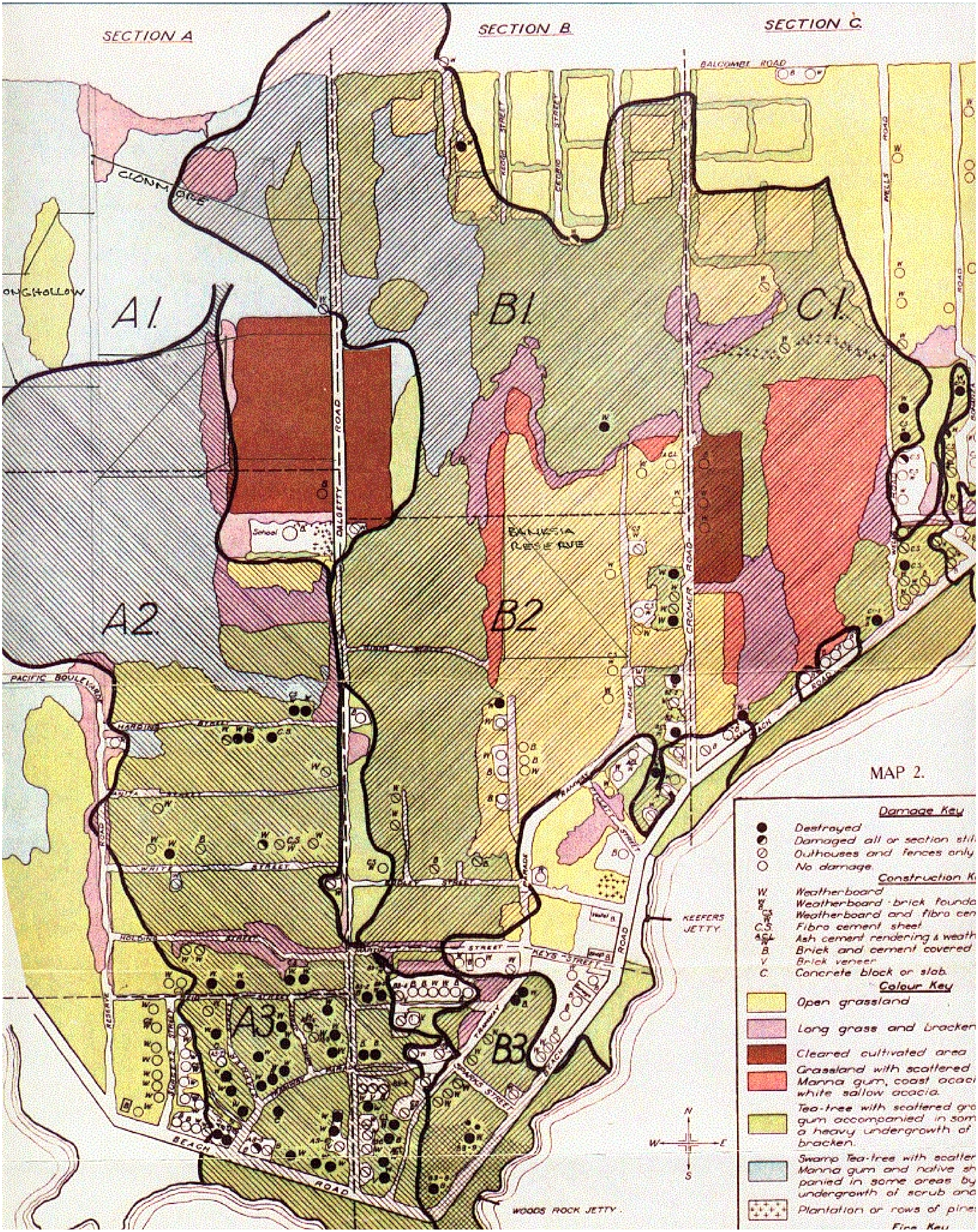
(b) The maximum gust of wind at Melbourne on January 14, 1944, 87 km/h occurring at 1007 L.M.T.

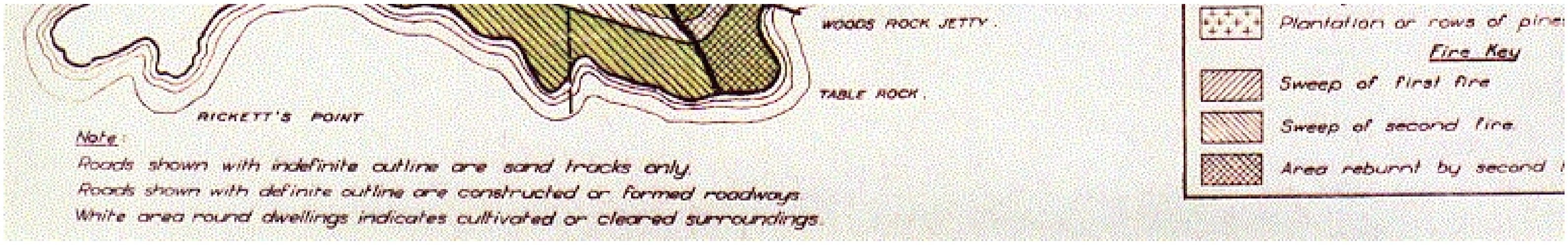
(c) The following is a description of the weather at Melbourne on January 14, 1944: -

> "Clear at first, overcast with cirrus cloud at 0740 L.M.T. Almost cloudless at 1040. Dust and smoke haze greatly reduced visibility.
> At 1640 L.M.T. dense dust haze all around. At 1940 L.M.T. there was a dense dust haze. Visibility very poor."

H. E. Daw, Government Printer, Melbourne

C12539/44 - 2


SECTION A
SECTION B
SECTION C
BALCOMBE ROAD
CLONMORE
A1.
B1.
C1.
A2.
B2.
A3
B3
BANKSIA RESERVE
School
DALGETTY ROAD
CROMER ROAD
WELLS ROAD
PACIFIC BOULEVARD
WHITE STREET
KEYS STREET
BEACH ROAD
KEEFERS JETTY
WOODS ROCK JETTY
MAP 2.
Damage Key
Destroyed
No damage
Construction Key
Weatherboard
Fibro cement sheet
Brick veneer
Concrete block or slab.
Colour Key
Open grassland
Cleared cultivated area
Fire Key


WOODS ROCK JETTY.
TABLE ROCK.
RICKETT'S POINT
Note:
Roads shown with indefinite outline are sand tracks only.
Roads shown with definite outline are constructed or formed roadways.
White area round dwellings indicates cultivated or cleared surroundings.
Plantation or rows of
Fire Key
Sweep of first fire
Sweep of second fire.
Area reburnt by second