WAHINE STORM DAMAGE IN WELLINGTON 10 APRIL 1968

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ABSTRACT

The Wahine storm of 10 April, 1968, was one of the most intense wind storms to have affected New Zealand since European settlement. The Wellington area, at the south-western tip of North Island, suffered the worst damage. This paper examines the spatial distribution of 3657 insurance claims made for storm damage in Wellington Region. Developed areas sited on hills and ridges, which tended to be aligned with the SSW wind direction, are shown to have suffered 30 percent less damage than developed areas on adjacent wide valley floors. Developed areas on flat low-lying ground less than one kilometre downwind of an open expanse of water suffered twice the damage of similar developed areas further inland. These trends are thought to be explained by differences in the roughness of the ground surface as presented to the wind stream. Topographic acceleration of wind streams is apparent in two areas.

INTRODUCTION

The wind conditions experienced in the Wellington region on the morning of 10 April 1968 were the most severe to have ever been instrumentally recorded in New Zealand at that time (New Zealand Meteorological Service, 1968). The high winds were caused by an unusually intense cyclone that had originated in the tropics. Although it never met the criteria for a hurricane, the cyclone caused winds that reached hurricane force in some of the more exposed places around Cook Strait. This paper examines the spatial distribution of claims made to the Earthquake and War Damage Commission as a result of damage from this one storm.

The cyclone was officially named Cyclone Gisele but became known in New Zealand as the 'Wahine Storm' because of the loss during the storm of the inter-island roll-on-roll-off freight and passenger ferry Wahine and 51 of its 733 passengers and crew. Ingram (1990) has given an account of this tragedy.

A brief summary of the weather in Wellington on 10 April 1968 is provided by the New Zealand Meteorological Service:

During the evening of 9 April 1968 the weather in Wellington was overcast with light to moderate rain. The wind was a fresh northerly which gradually died away about midnight. Shortly before 2 a.m. the wind changed to a light southsouthwesterly and heavy rain set in and continued on into the afternoon of the 10th. The wind increased rapidly. During the morning, between 0700 and 1200 hours, it reached exceptionally high velocities (gusting to 107 knots at Kelburn), but decreased rapidly in the early afternoon and turned to a light to moderate northwesterly. (New Zealand Meteorological Service, 1968).

EWDC CLAIMS

The Wahine Storm of 10 April, 1968, resulted in 3657 claims for damage within the Wellington region being made to the Earthquake and War Damage Commission (EWDC). (The Commission provides insurance cover for other types of disaster damage besides earthquake damage). The insurance claim descriptions (as contained in the Disaster Register) reveal little about the type of wind damage but buildings under construction did appear to be more vulnerable to damage than other buildings (Gee, 1992).

The EWDC paid out on 72 percent of claims made within the Wellington Region. The total cost of all payments within the Region combined was $625,170 (over $5.5 million in 1988 values); the mean payment was $237 while the median was only $58 (over $500 in 1988 values). The largest single payment was $441,128 for a claim in the Rongotai industrial area.

An analysis of newspaper and eyewitness reports of damage arising from the storm (Gee, 1992) discovered that the numbers of claims to the EWDC represented only about one quarter of the actual number of buildings damaged. Claims made to insurance agencies other than the EWDC, and damage for which no claims were made, will not appear in the EWDC records.

The addresses of claim locations were extracted from the EWDC Disaster Register. The locations of the claims were then plotted onto maps of the Wellington region at a compilation scale of 1:10 000. Because the number of insurance claims from a particular area will, to some extent, be a reflection of the number of buildings within that area, differences in building density were compensated for using Valuation Department roll areas. The number of assessments (an approximation of the number of buildings) within each roll area is known and it is therefore possible to calculate the number of claims per 1000 assessments arising from damage during the Wahine Storm. It has been necessary to use 1987 figures for the number of assessments in each roll area because 1968 values are not available. Comparisons of 1968 and 1988 street maps of Wellington City (NZMS 17 Sheet Wellington and Infomap 271-37) have permitted the effects of additional residential developments built between these dates to be taken into account.

In the analysis that follows, frequent reference will be made to individual suburbs within the Wellington region. Readers will find it convenient to have the appropriate Wellington street maps on hand for easier understanding of the spatial relationships as they are examined.

Fig. 1 shows the numbers of claims per 1000 assessments for each of the valuation roll areas. The primary wind direction during the storm was from the south and southwest and most of the damage was caused in areas exposed to this direction.

ANALYSIS

Sheltered Areas

Claims do not exceed 26 claims per 1000 assessments anywhere in Upper Hutt City, Stokes Valley, Wainuiomata or Eastbourne. All these areas have at least some protection from winds coming from the south.

Wainuiomata lies at the northern end of a valley trending NNE-SSW but the valley is narrow — only half a kilometre wide in places — and not straight, so the valley sides will provide significant resistance to wind travelling along the valley. Much of the damage that did occur in Wainuiomata occurred at the south end of the urbanised area and along South Coast Road which runs down the valley to the south coast between Pencarrow Head and Baring Head.

Damage densities in Tawa range from 0 to 22 claims per 1000 assessments (all well below the regional mean of 30). Densities within Porirua City are generally very low, only 4 roll areas have densities higher than 24 claims per 1000 assessments and most have values below 10.

Much of the new housing construction in the Wellington region since 1968 has been in the eastern half of Porirua City. Whitby and Ascot Park have been entirely built since 1968 — hence the values of 0 in these areas. Roughly one third of the claims for buildings under construction for the Wahine Storm are from Waitangirua with a few in Cannons Creek (the remainder are thinly scattered over the rest of the region with no apparent clustering). These claims will have been made by commercial builders in the process of building rental houses for the New Zealand Government.

Porirua East and Cannons Creek are areas of extensive state-owned rental housing. As the State carries its own insurance in New Zealand, damage to completed state-owned properties will not result in claims being made to the EWDC.

Concerning the 4 roll areas in Porirua City with density values above 24, one is the main industrial area (12 claims, 176 assessments, density value 68), one is the main business district (8 claims, 165 assessments, density

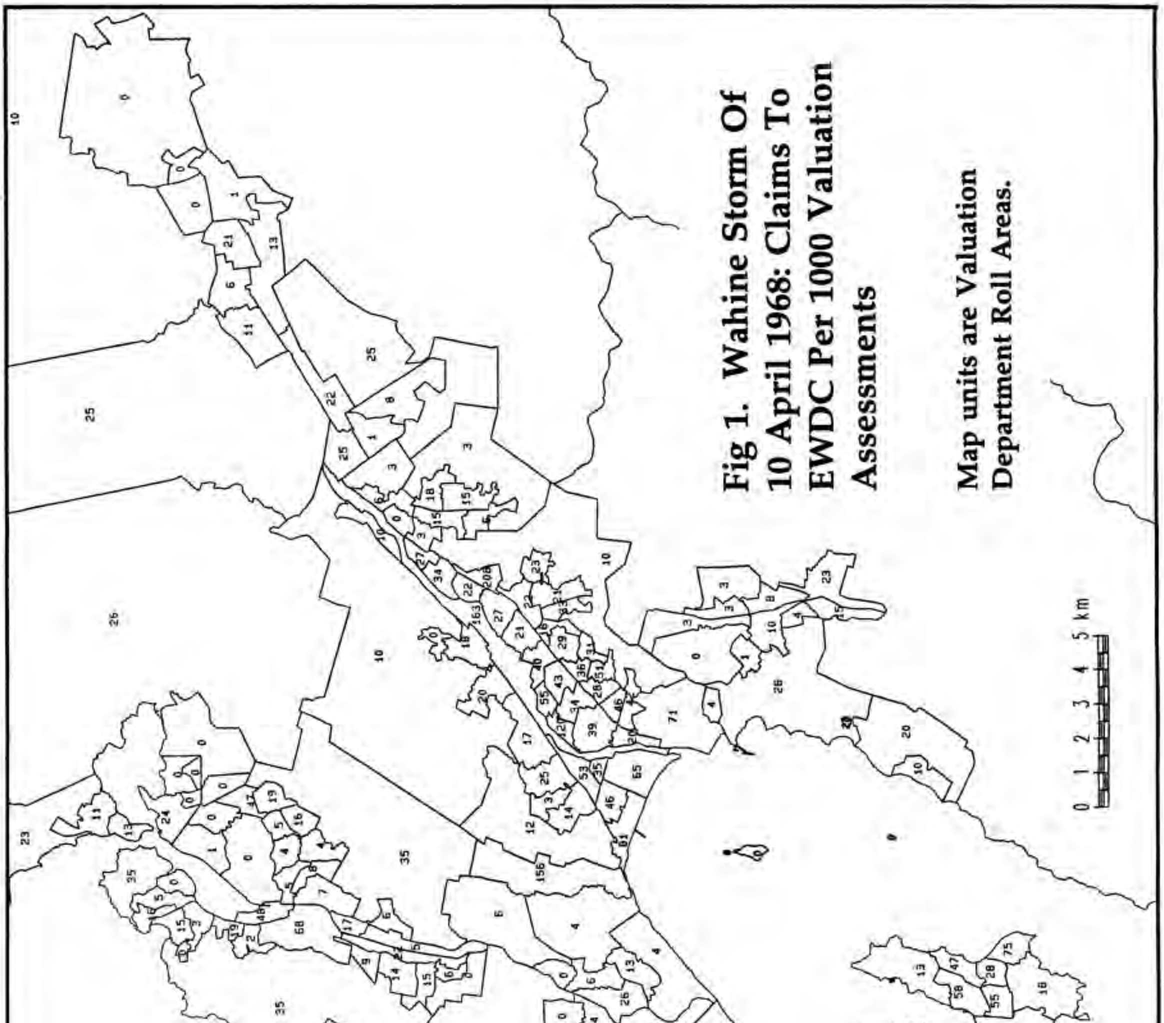

Fig 1. Wahine Storm Of 10 April 1968: Claims To EWDC Per 1000 Valuation Assessments

Map units are Valuation Department Roll Areas.

value 48), one is Waitangirua with its high number of vulnerable buildings under construction, and one is the rural roll area surrounding the urbanised parts of Porirua City. This last roll area, occurring as 4 separate pieces, has 2 claims from its 57 assessments giving a density of 35 claims per 1000 assessments, clearly of no real significance.

The central business area and industrial areas of Porirua therefore have high damage but the rest of the city has relatively little, values of 5-20 being the general level of damage as judged from the areas fully developed in 1968.

Lower Hutt

In Lower Hutt City, with the exception of Stokes Valley, nearly all of the claims per 1000 assessments values lie in the 20 to 50 region. The western Hutt hills, perhaps surprisingly, have a maximum value of only 25. This will partly be due to development taking place since 1968 (the roll area with a value of 0 has been entirely developed since 1968) but even allowing for this later development, damage densities on the valley floor are greater than those on the western hills.

No trends are apparent on the parts of the floor of the lower Hutt Valley away from the harbour except that the roll area incorporating most of the central business area has a very high value of 120 claims per 1000 assessments.

An industrial area in Taita with 48 assessments has a value of 208 claims per 1000 assessments which represents 10 claims. While I attach little significance to the actual value of the claim density, I conclude that industrial areas are particularly vulnerable to wind damage, possibly even more so than business (office and retail) areas.

Petone (not including the Korokoro hills) and the Seaview-Gracefield area of Lower Hutt have values of 46-81. The higher values here on the edge of the harbour are attributed to the fact that there is nothing to slow the wind speeds from the south. The Seaview-Gracefield industrial area is at the mid-point of values for this group (71) and not higher as we are coming to expect for industrial areas. Seaview and Gracefield may however be sheltered a little from the south by Point Howard and the values thereby brought down again. The western Petone foreshore has a greater claim density than eastern Petone but this can be attributed to the effect of combining nearshore and distant-shore areas in the latter case. I conclude from this that places within about 1 km of the harbour had about twice the damage density of other parts of the lower Hutt Valley. There is no channelling effect apparent from the converging sides of the lower Hutt Valley.

The roll area incorporating the lower Hutt River and its banks was a value of 163. With only 49 assessments this represents just 8 claims and could arguably be ignored. But because river banks are often areas of grass vegetation, and little else, they could be expected to allow higher wind speeds and may well be areas of greater damage potential.

For Petone and Lower Hutt City I conclude that areas worst affected were those within 1 km of the exposed harbour shore, with the areas sheltered a little by Point Howard being slightly less affected. Further up the Valley, shelter from the eastern Hutt hills and surface roughness provided by buildings on the valley floor reduced wind speeds, thereby reducing damage by about half. Damage along the exposed river banks may be several times that of built up areas and may further emphasise the importance of relative surface roughness. Damage in the central business area is about 3 times that in residential areas. Damage on the western Hutt hills is about half that on the adjacent valley floor, even where little development has occurred since 1968. An explanation for this will be given when Wellington City is considered.

Western Suburbs

There were 6 claims from along Horokiwi Rd which, with only 32 assessments in the eastern part of this area, gives a value of 156 claims per 1000 assessments. The western part of this area has 209 assessments and 4 claims per 1000 assessments. If both areas are combined (the road is the boundary) a more appropriate figure may be obtained: 6 claims per 241 assessments gives 24 claims per 1000 assessments — similar to most of the western Hutt hills. The western Horokiwi roll area includes, however, a small part of northeastern Newlands developed after 1968 so the actual density for the roll area may be somewhat greater than 24.

Claim densities in Newlands, Johnsonville, Khandallah, Ngaio, Wilton and Karori are similar to, if not lower than, densities on the floor of the lower Hutt Valley. Density values in these northern and western parts of Wellington City are mostly in the 12-30 range. Roll areas with densities below 12 tend to be those with significant parts developed since 1968 such as Churton Park, Grenada and northwestern Ngaio. These northern and western suburbs lie in moderate sized valleys (about 1 km wide) at an elevation of between 100 and 200m above sea level. The tops of the surrounding hills are typically 200-300m higher than the valley floors. Most development is on the valley floors, although a significant amount extends some distance up the valley sides. The hill tops are generally undeveloped except in Newlands and eastern Johnsonville.

The southeastern part of Khandallah lies outside these valleys and occupies a hillside overlooking the harbour. This roll area, generally of expensive housing, has a damage density of 41 claims per 1000 assessments. This may be a better estimate of damage potential for this type of topographic situation than the western Hutt hill values. Alternatively, the higher value may be due to wind accelerating over the hill separating Ngaio and Ngauranga gorges, Wellington Harbour and Ngaio valley.

Wellington City

The remainder of Wellington City has claims per 1000 assessments values mostly of 25-85.

For the areas exposed to the south, that is with no hills obstructing winds from the south, hills have values of 50-60 while valley floors have values of 70-90. Damage densities are higher on the valley floors than on the adjacent hillsides and ridge crests. The hilltop areas of Kingston and Brooklyn have values of 50 to 59; the hilltops of Melrose and Houghton Bay similarly have values of 53 and 60 respectively. The hilltop area of Southgate has a value of 37 but includes some sheltered parts at its northern end and some of the more exposed southern parts were not fully developed until after 1968 (Earn Place, Orchy Cres, and Bann St). A value of about 60 could therefore be more appropriate for the exposed Southgate hilltop. The area in western Brooklyn known as Kowhai Park has been entirely built since 1968 so a value of (say) 70 is probably appropriate for the roll area containing Karepa and Mitchell streets rather than 52.

The flat lying Kilbirnie — Lyall Bay region has values from 88 to 70, the high values closest to the south coast and the lower values at the northern end.

The valley extending inland from Island Bay rises gradually but steadily until the northern end of Berhampore. Another valley then descends from southern Newtown and through the Basin Reserve area to Courtenay Place at the eastern end of the Wellington central business area. Claim densities increase from 70 at the Island Bay coast, to 85 a little inland, to 104 at Berhampore — the opposite of the trend observed from Lyall Bay to Kilbirnie. I conclude that the increase in wind speeds resulting from constriction in the valley caused by the Berhampore-Newtown saddle is more than making up for the decrease in wind speeds expected from surface roughness of a built-up area. Some concentration of winds may also be arising from the gradual increase in height of the ridges on either side of the valley — especially the Kingston ridge — even though the valley width remains constant. A possible objection to this is that houses in Berhampore tended to be older and more poorly maintained than other areas, accounting for the increased damage. This view is rejected here because Petone, which had similarly poorly-maintained buildings, has a similar damage density to Lyall Bay which had well-maintained buildings.

Claim densities decrease as expected once over the Berhampore — Newtown saddle, from 104 in Berhampore to 72-79 in Newtown, to 60-64 in the Mt Cook and Mt Victoria areas, and 47 at Oriental Bay. Mt Victoria has a higher density than Mt Cook but parts of Mt Victoria lie within the Wellington central business area which accounts for this. Some of the Oriental Bay roll area is completely sheltered from the south but a significant proportion is on a ridge overlooking the eastern end of the Wellington central business area and is therefore not sheltered. A density value of 55-60 could perhaps be appropriate for this unsheltered area.

The Owhiro Bay area has a value of only 42 claims per 1000 assessments, rather lower than expected for the south coast. This area was fully developed in 1968. Happy Valley, extending northwards from Owhiro Bay is steep-sided and narrow, only about 100-200m wide at its floor, and this will slow the wind speeds. Some funnelling could be expected from the shape of the bay and surrounding hills but high-speed winds would be forced above the developed area by the restrictively narrow topography. Half of the claims in Owhiro Bay are from houses at the base of the seacliff with only the road between them and the sea.

An examination of claim locations (not shown in Fig. 1) reveals a surprising (and unexplained) lack of claims along the point between Island Bay and Houghton Bay. This stretch of road has a line of houses along the base of the seacliff with just the road between them and the sea.

Claim densities in the Wellington central business area are high, ranging from 77 to 178 claims per 1000 assessments. Assuming that if this area was occupied by residential development it would have a value in the 50s, the business area has a density 2-3 times that of a residential development — the *business effect*. Each building counts as only one assessment but many tenants may occupy the one building. Each tenant however has to make their own claim for any damage they themselves have sustained.

The Thorndon area has densities of around 60-70 which is higher than might be expected nearly 10 km from the south coast although the close proximity of the steep, tall Wellington Fault scarp may be creating some funnelling effects. This area has been heavily redeveloped since 1968 (housing has been replaced by urban motorway) and there are almost certainly fewer buildings now compared to 1968. This would raise the apparent density values.

The eastern parts of Kelburn and Aro Valley have densities of 47 and 48 while the more sheltered western parts have densities of 21 and 28. The elevated areas of eastern Karori and Northland have densities in the middle 30s. The topography of the western Karori, Northland, Thorndon, Kelburn, Aro Valley area is very complex and criss-crossed by deep, narrow valleys. Wind flow patterns are likely to be similarly complex.

Hataitai, occupying a valley between the hill Mt Victoria and Evans Bay, has values of 42 and 45. The hill sides are probably slowing wind down more here than in northern Miramar where the valley floor is wider but the topographic situation is otherwise similar. Nearly half the claims for southern Hataitai come from Overtoun Terrace, a street running along the ridge crest between Evans Bay and Hataitai Valley. This is probably due to the wind accelerating as it rose over the leading nose of this north-south aligned ridge.

Roseneath, which is very exposed to the prevailing northwest winds, is sheltered from the south and has a claim density of 21 claims per 1000 assessments, well below the average values for Wellington City.

Strathmore Park is protected by hills to its south and therefore has a density of only 18. Miramar is exposed to the SSW (a little sheltered from the south) and the surrounding hills probably also slowing the wind, has values of 55 and 58, somewhat lower than the Lyall Bay — Kilbirnie region. The hills to the east of Miramar have lower values than the valley floor (47) following the trend observed in other areas. The low point in the ridge connecting Beacon Hill and Seatoun Heights is sheltered from the south and has a low density of just 28. The Point Halswell area to the north of Miramar also has a low value but this will be partly due to much of Maupuia being developed since 1968.

Seatoun, although protected from the south by a high ridge along its southern side, has a high claim density of 75 claims per 1000 assessments. This is comparable to the densities in Lyall Bay and Kilbirnie. The cause of this high density is unexplained.

DISCUSSION

There are four main trends apparent from this analysis: the *business effect*, the *industrial effect*, the influence of ground surface friction, and the influence of topography.

Business Effect

Commercial areas have an apparent susceptibility to wind damage (by numbers of claims) two to three times greater than residential areas for the 10 April 1968 storm. Much of this is attributed to many buildings having multiple tenants, each of whom make their own claim to the EWDC, resulting in an anomalously high rate of claims per assessment. This 'central business area effect' is visible in all commercial areas, including those in Upper Hutt, Petone and Johnsonville which are not neatly delineated by roll area boundaries. Commercial areas may or may not have greater susceptibility to wind damage than residential areas. It is not possible to answer this question from the data used in this study.

Industrial Effect

Industrial areas also appear more susceptible to wind damage (by numbers of claims) than residential areas for this storm. The data unfortunately does not permit an estimation of how much more susceptible industrial areas appear to be. A large warehouse or factory is believed to be more likely to be damaged than a small dwelling simply because it is bigger. A warehouse and a dwelling both count as only one assessment. The *industrial effect* may be solely due to increased building size. Industrial buildings may have a similar or lower susceptibility to wind damge compared to residential buildings on a per square metre basis.

Surface Friction

Wide flat valley floors suffered greater overall wind damage than hillsides and hilltops (by numbers of claims). This is attributed to the influence of the roughness of the surfaces the wind streams have to pass over. Open stretches of water have the lowest surface roughness. Flat low-lying areas less than one kilometre downwind of an open expanse of water suffered twice the damage of areas further inland during the Wahine Storm.

Urban development on flat land has a greater surface roughness than open water. Buildings tend to be reasonably close together (thereby sheltering each other) to get maximum use out of the valuable land and the whole development presents a fairly flat surface of roof and tree tops to the wind stream, one to two storeys above the ground surface.

Established urban developments on hillsides and hilltops have a greater surface roughness than those on flat valley floors. The nature of the terrain prevents as intensive land-use as flat low-lying land and buildings tend to be built further apart giving each other less shelter. (When plotting incident locations it was noted that the average distance between street addresses on hills is about twice that of street addresses on flat land). Trees are more common on hills as land is less valuable and ridges and spurs create considerable rumpling of the ground surface. The combination of topography, and irregular placement of trees and buildings on that topography, present a rough surface to wind streams. (The anemometer at Kelburn is 19 metres above ground level to get 'a good exposure' but is still affected by turbulence, according to Meteorological Service staff). All other factors being equal, damage on hills appears to be about 30 percent lower for the 10 April 1968 storm than for adjacent flat low-lying areas.

Topographic Acceleration

The effect of topography in accelerating wind streams is thought to be visible from the Wahine Storm data in at least two places: the Island Bay — Berhampore — Newtown valley, and the high-elevation area around Karepa and Mitchell streets in west Brooklyn. The first is attributed to some kind of wind channelling effect accelerating the wind travelling up the valley. The second is attributed to a much larger-scale influence of high hills to the southwest of Wellington City. The wind mass from the south and southwest will have accelerated as it passed over these high areas, including the 299m peak Polhill near Brooklyn. Acceleration effects may possibly be visible in Hataitai and Khandallah.

The tops of leading noses of ridges — with respect to the wind stream — will experience very high wind speeds as wind streams pass over them. Discussion with a 'long-term' resident of Orchy Crescent (built since 1968) revealed that damage to buildings from southerly winds is common in that area. Orchy Crescent lies at the crest of the nose of a large ridge which points out into Cook Strait. Most houses have had their roof guttering and downpipes torn away on some occasion.

In 1968, there were no areas in this topographic situation that had been developed and which are also delineated by a roll area boundary. It is therefore not possible to quantify the effect of such topography on wind induced building damage using the Wahine Storm data. The Normandale and Belmont areas of Lower Hutt are at the top of a scarp rising obliquely to the wind direction — the wind presumably slowed by the side spurs of the escarpment.

The newly built (in 1968) area of Kingston lies partway along a ridge and suffered normal hilltop damage despite media reports to the contrary. A full analysis of this discrepancy has been given in Gee (1992).

Virtually all trends observed on the claims per 1000 assessments map (Fig. 1), even quite subtle ones, can be explained by topographic factors and types of development.

CONCLUSIONS

The very large number of claims made to the EWDC for building damage arising from the Wahine Storm of 10 April 1968 reflect the tremendous impact of that wind event. It was probably the most severe windstorm to have occurred in New Zealand since European settlement. Claims made to the EWDC represent only one quarter of the buildings actually damaged by the Wahine Storm.

Analysis of the spatial distribution of claims arising from the storm on 10 April 1968 produce four main conclusions:

1. Commercial areas have a claim density two to three times greater than residential areas but is attributed to commercial buildings often having multiple tenants.
2. Industrial areas appeared more susceptible to wind damage than residential areas but this may be solely due to commercial buildings being generally larger than residential buildings and commercial buildings may have a similar or lower susceptibility to wind damage on a unit area basis.
3. Wide flat valley floors suffered greater damage overall during the 10 April 1968 storm than hillsides and hilltops. This is attributed to the influence of the roughness of the surface the wind streams had to pass over and the fact that the majority of ridges were aligned with the wind direction. Flat low-lying areas less than one kilometre downwind of an open expanse of water suffered twice the damage of areas further inland. Damage in established urban developments on hillsides and hilltops appeared to be about 30 percent lower than for adjacent flat low-lying areas due to the greater surface roughness of hill areas.

The tops of leading noses of ridges — with respect to the wind stream — do experience increased wind speeds as wind streams pass over them. In 1968, there were no areas in this topographic situation that had been developed so this cannot be shown from the Wahine Storm data. Damage to buildings from southerly winds is common in Orchy Cresent (developed after 1968) which lies at the crest of the nose of a large ridge which points out into Cook Strait. Most houses in this street have had their roof guttering and downpipes torn away by wind on some occasion since their construction.

4. The effect of topography in accelerating wind streams is known in two places from the Wahine Storm data: the Island Bay — Berhampore — Newtown valley, and the high-elevation area around Karepa and Mitchell streets in west Brooklyn.

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