



- **Proposed Changes to B2/AS1**
Report to Building Industry Authority

Attachment 3:
Report on E2/AS1 Risk Matrix and Weathertight Homes
Resolution Service Data

November 2003

Introduction

A wide range of factors is believed to have contributed to current problems with leaky buildings (Hunn Report, Government Administration Committee Report). However, feedback from those involved in inspecting and repairing leaky buildings has indicated that buildings containing particular design features are more prone to leaks.

An early example of this was evidenced by the production of the Weathertightness poster produced by the Weathertight Buildings Steering Group in 1991. This concept was adopted in the public comment draft of E2/AS1 released in June 2003 where two categories of risk were defined. Buildings defined as “low risk” were allowed to use both direct-fixed claddings and claddings fixed over a cavity, while those defined as “high risk” had to incorporate a cavity behind all claddings.

This division into only two classes of risk was recognised as providing simplicity, but resulted in a very inflexible and conservative position. An alternative option was considered and discussed in the commentary material that accompanied the public comment draft E2/AS1. This more flexible option received widespread support and has therefore been developed further for inclusion into E2/AS1.

This document briefly summarises the rationale behind the risk matrix and the data that has been used to support and inform the decision-making process. It covers both the scientific rationale and data from reports on leaking buildings – particularly that from the Weathertight Homes Resolution Service (WHRS).

1 Technical and Scientific Considerations

The following principles have been applied to the development of the risk matrix:

- **Wind zone**

Where a wind pressure difference exists across a cladding, air will move from high pressure to low pressure and, if it is raining, it will carry water with it. Theoretically, the greater the design wind pressure the more likelihood of leaks.

This is recognised in existing Standards and Approved Documents where requirements vary depending on the wind Zone (e.g. NZS 3604 requires wind barriers behind certain claddings in VH zones).

- **Junctions and Penetrations**

Most cladding materials are either inherently waterproof, or have a surface finish applied to make them waterproof. Where holes are made in the cladding component or where individual cladding components are joined or abut other parts of buildings, that creates vulnerable points in a cladding system. Parts of buildings that contain either very complex details or more details to waterproof are therefore likely to suffer more leaks.

- **Number of storeys**

There are several reasons why the number of storeys is likely to affect the risk of weathertightness:

- *Height above ground*

An increase in the height above ground results in an increase in design wind pressure. However, within the scope of the E2/AS1, this effect is not likely to be significant when compared to the Wind zone option described above.

○ ***Catchment area***

Increasing the number of stories results in an effective increase in the catchment area of the wall (except in zero wind situations with eaves present).

○ ***Penetrations and openings***

Where weak points associated with penetrations and openings are at a greater height in a building, the vulnerability to leaks increases with the added exposure.

○ ***Eaves width***

Eaves shelter walls from rainfall. While a nominal eaves' width provides shelter in zero wind situations, rain is often accompanied by wind so increasing eaves' width provides additional shelter. However, increasing the building height reduces this effectiveness. An analysis of buildings in Vancouver showed a strong relationship between eaves width and leaks in the walls of buildings.

2 Data from assessments of leaky buildings

Theoretical considerations need to be validated by real world data. Feedback from parties inspecting buildings backed the theoretical considerations outlined above. However, where inspection reports have been carried out on buildings, owners are, in most cases, very cautious about publicity and reports are usually confidential.

Four sources of data have become available over the past two years that provide further supporting information:

- BIA funded a study at UNITEC (Murphy, 2000) on pre-purchase inspection reports carried out by Prendos.
- Philip O'Sullivan presented the results of a review of over 50 leaking house reports prepared by Prendos at a CINZ forum in 2002.
- BIA commissioned a report from Sue Clark on reports of leaky houses in reports held by BRANZ (Clark, 2003). A further statistical analysis of this data was carried out by Bassett et al (2003).
- The Government set up the Weathertight Homes Resolution Service (WHRS) in late 2002. Owners of leaky buildings can apply to the WHRS and, for a small fee, take part in a process of mediation and potentially adjudication. Part of this process involves an inspection and report on the leaky building. Data on 211 out of 2130 applications was available on 7 November 2003.

There are limitations to all of these sources of data, but they do provide an independent check on the theoretical proposals.

a) UNITEC Report

The UNITEC Report, *Auckland House Cladding Survey* was carried out in December 2000 on behalf of the BIA. The report looked at 287 pre purchase inspections carried out by Prendos Ltd between the years 1996 and 1999. The research objectives were to:

- Investigate any relationship between the wall cladding system(s) adopted and the type and frequency of any defect or omission.
- Investigate any relationship between the age of the cladding system –and the type and frequency of any defect or omission.
- Compare the performance of wall cladding materials during the period about and subsequent to the introduction of the New Zealand Building Code with performance prior to that period.

Limitations

The report identifies many of the limitations associated with the information. These include:

- The sample size of only 237 pre-purchase reports
- The bias towards houses of higher value and located in the Auckland region
- There is also an over representation of homes from the 1990's and under representation of homes from the 1940's and 1960's.

Other limitations are:

- The inherent bias associated with using pre-purchase reports. These reports are often limited to visual inspections, and may have a tightly defined scope in order to keep costs down.
- Information is unlikely to be quantitative, as non-destructive testing equipment was not widely used at the time of the reports.

Main Conclusions

Despite the above limitations the report still represents an improvement over information available prior to its release. Some of the conclusions and recommendations are:

- There were more defects per cladding case than ten years prior to the study.
- Identification of trends away from weatherboard claddings and the growth of EIFS systems.
- The importance of correctly detailed and installed head, sill, jamb flashings.
- The recommendation that research be carried out into why balcony leaks are prevalent, the use of flashings and the high incidence of defects in Stucco and EIFS systems.

b) Prendos Analysis

The report by O'Sullivan, P. *Pilot study of risk factors associated with building weathertightness failures*, was presented at the Claddings Institute of New Zealand forum on weathertight buildings in 2001.

Limitations

- The sample size was only 250 household units.
- The sites were located only in Auckland .

- The bias was towards houses of higher value, with a median value of \$450,000.

Main conclusions

- There was a high frequency of water leakage sites with monolithic claddings
- There were clear links between the height and complexity houses and those with particularly high numbers of leaks.
- Poorly executed details, particularly around balconies, were responsible for many leaks.

c) Clark Report and Supplementary Analysis

The report by Sue Clark, *Weathertightness Failures: Associated Risk Factors*, March 2003, and supplementary analysis by Clark, Bassett, Camilleri, *Building Weathertightness Failures – Associated Risk Factors*, 2003, are a detailed investigation of 305 leaky house reports held by BRANZ . The reports cover houses built between 1985 and 2002 and aim to identify risk factors associated with water leaks.

Limitations

- The relatively small sample size may not be truly representative of the overall housing population
- The report was not able to resolve population-based risk factors for site wind exposure and the extent of eaves width

Main Conclusions

- The high risk of water leaks associated with junctions between materials and components.
- The increased risk of water leaks with increased building height
- Monolithic type claddings or mixed claddings had the highest incidence of leak positions
- The average number of locations with leaks increased with the level of complexity of the building envelope.

3 WHRS Data

WHRs had over 2130 buildings registered at end of October 2003. These are buildings that the owners believe are leaking. Where a building is deemed to meet the criteria set for eligibility for WHRS, a WHRS Assessor inspects and produces a report on the building.

The report identifies the condition of the building, sources and locations of leaks, the likely repair costs along with detailed data on the house and its cladding. The Assessor also completes a summary check form that is then entered into a database. This data has been made available to BIA (with all owner and location details removed) for analysis.

Limitations

- At 7 November 2003, data was available for only 211 buildings or approximately 10% of the total number of cases at that time.
- Data has been supplied by individual assessors and, in all but a few cases, has not been tested in the resolution process.

- Unknown and unidentified entries are higher than is desirable, but early assessments did not record detailed data that was later recognised as being useful for the wider industry.
- It is not possible to view the original reports or talk to the individual assessor to clarify unusual aspects of the data.
- In a large number of cases, the timber treatment type is not recorded.

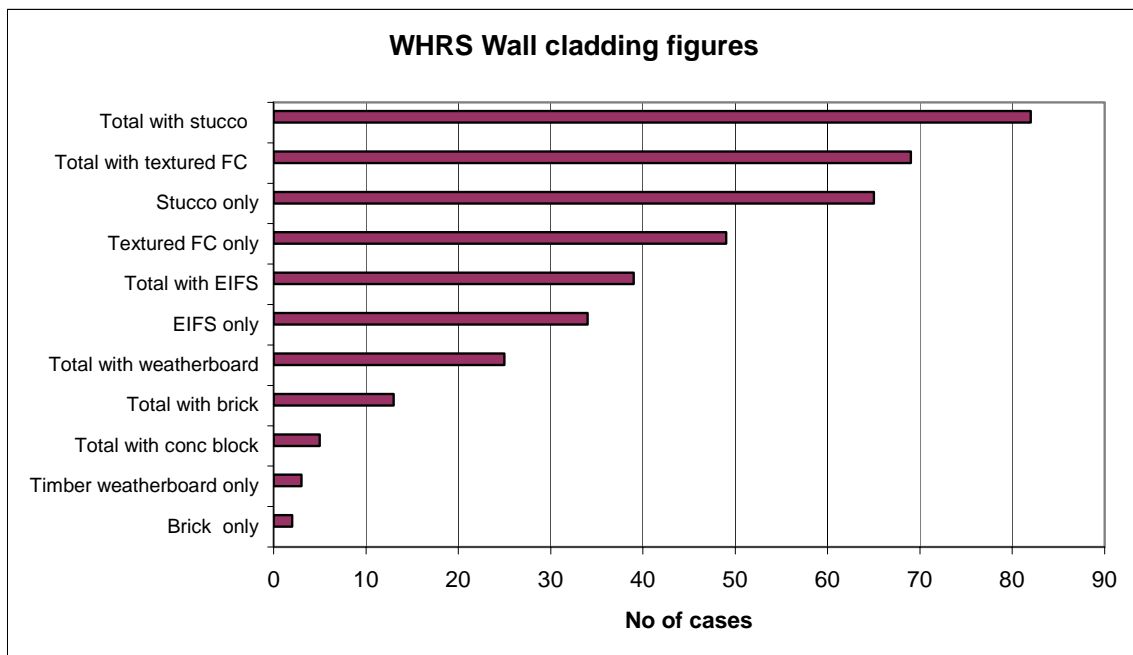
Advantages

- The reports are prepared on houses officially recognised as leaking
- The assessors have all had a minimum level of training which results in better consistency among reports.
- Assessors have the advantage of both resistance and capacitance moisture meters and are able to drill holes in claddings
- Detailed data summary sheets have since been compiled to ensure more consistent capture of relevant details into the database.

Basic summary of WHRS Data

Appendix 6a contains a breakdown summary of the data from the full data set provided by WHRS on the 211 buildings.

a) Cladding types



The distribution of cladding types is shown in Figure 1:

Figure 1: WHRS Cladding Distribution

As shown, stucco was the most common cladding type in the WHRS data, followed by textured fibre cement and EIFS. 21% of the buildings contained more than one cladding.

While only two cases out of 211 had brick veneer as the sole cladding, another eleven had brick as one of the claddings present on the building. Only three cases of horizontal timber

weatherboard as the sole cladding were present, but a total of 25 cases had timber weatherboards as one of the claddings.

b) Number of storeys

The distribution of leaky buildings by number of storeys is shown in Figure 2

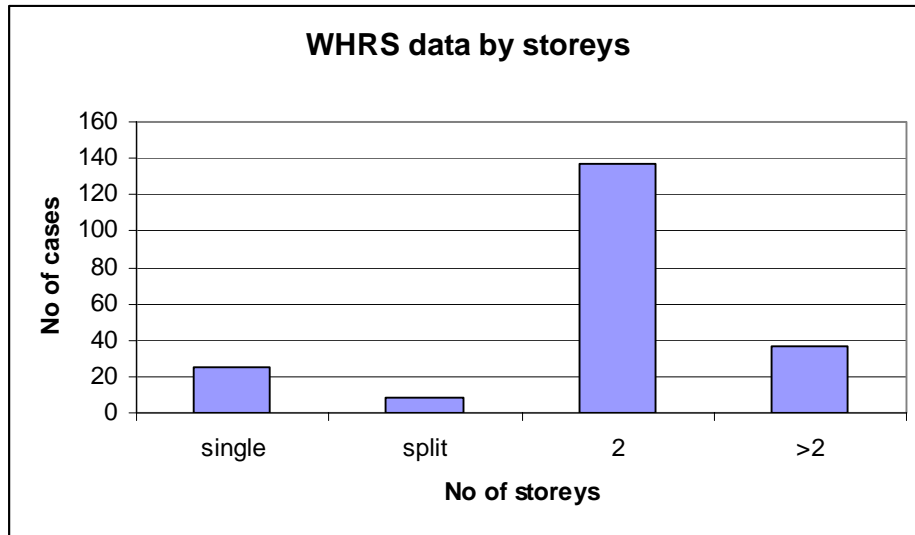


Figure 2: WHRS data by storeys

c) Wind zone

The distribution of leaky buildings by wind zone is shown in Figure 3:

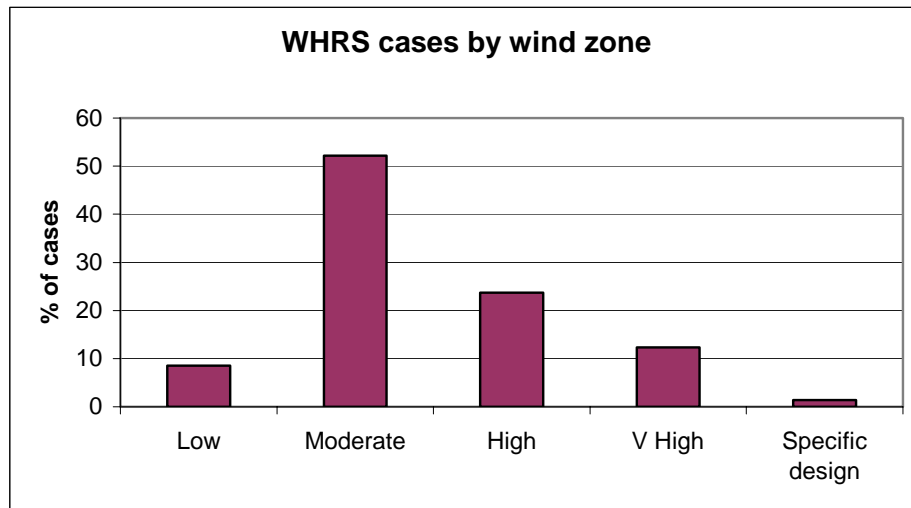


Figure 3: WHRS wind zone cases

The data from the analysis of BRANZ reports and anecdotal feedback from building assessors do not show a strong relationship between wind zone and the incidence of leaky buildings. As shown in Figure 3, initial data provided by WHRS also provides no clear indications of wind zone effects.

Taking this uncertainty into consideration, it is recommended that, while Wind zone should be included in the risk matrix, the weighting given to it should be less than that for those factors with a more reliable positive connection with leaks.

d) Eaves width

The distribution of leaky buildings by eaves width is shown Figure 4:

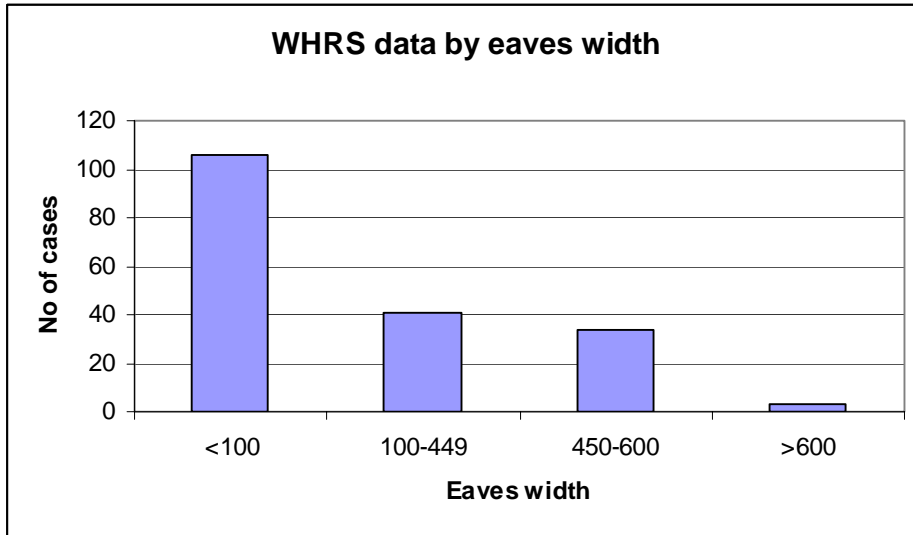


Figure 4: WHRS data by eaves width

It should be noted that, due to the way the eaves width is recorded in the summary sheet, there is a higher degree of uncertainty over this data than other parts of the database.

e) Locations of leaks

Figure 5 shows the location of leaks in the WHRS data.

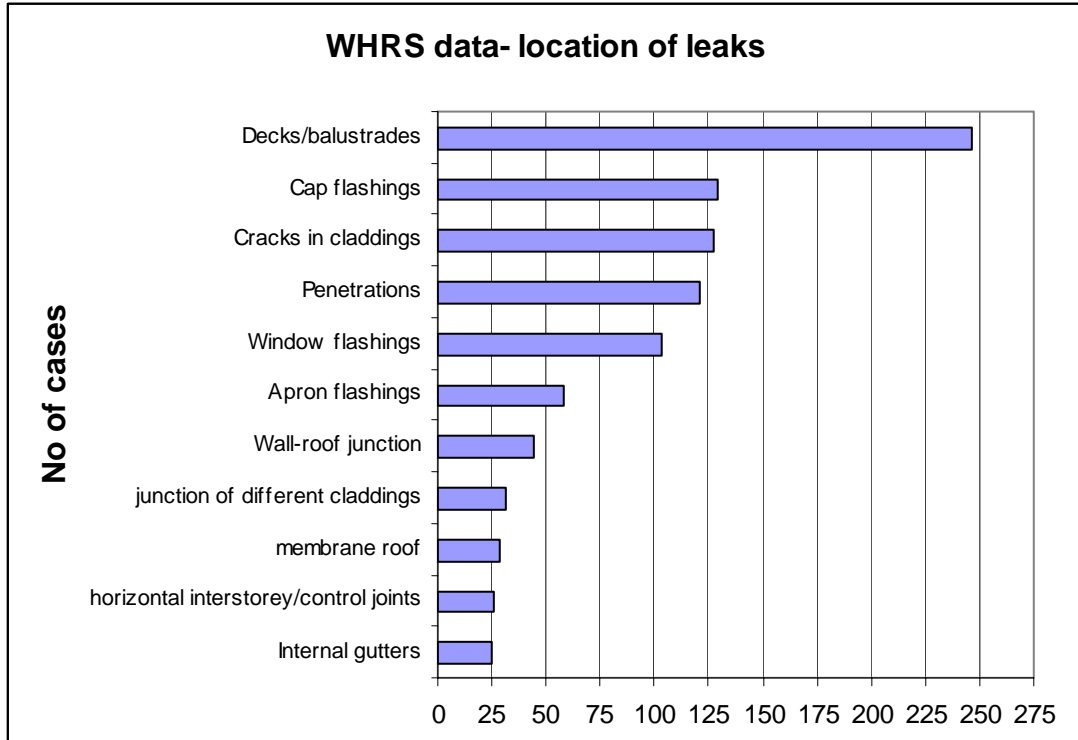


Figure 5: WHRS data: Location of leaks

It should be noted that a building may have several component parts causing leaks and several leaks associated with each component. This explains why the total of some leak sources exceeds the number of buildings.

f) Wall Complexity

Figure 6 shows the distribution of WHRS cases by wall complexity.

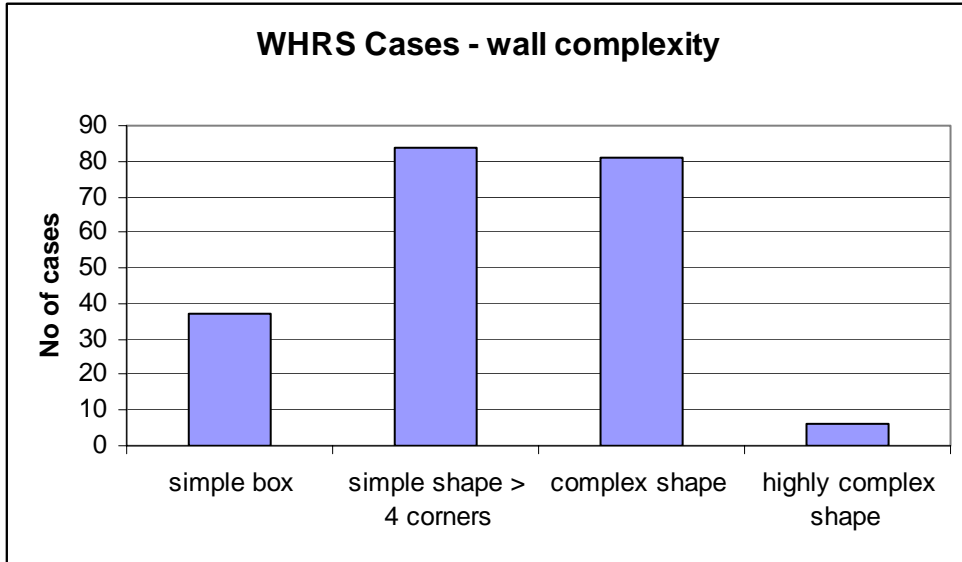


Figure 6: WHRS Cases - wall complexity

g) Roof Complexity

Figure 7 shows the WHRS data broken down by roof complexity.

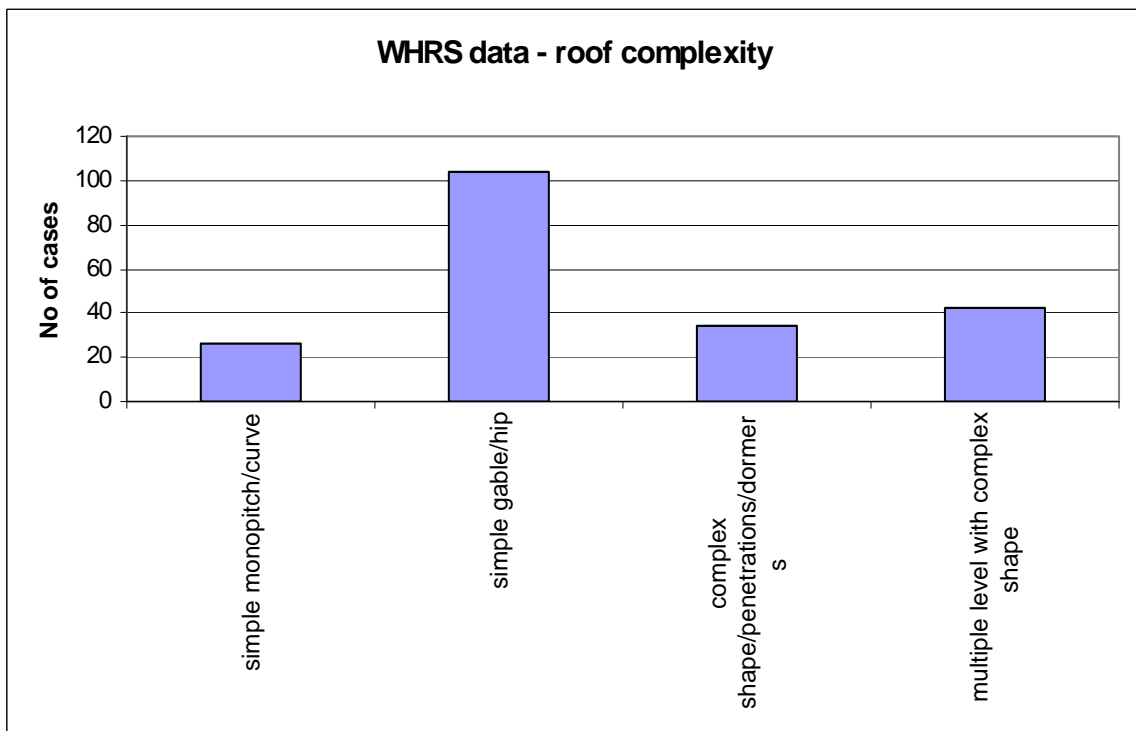


Figure 7: WHRS data - roof complexity

4 Comparison of WHRS data to base population

To gain an understanding of the significance of the WHRS figures it is necessary to compare them to the base population of residential units built over a comparable period. This allows an estimate of whether a particular cladding is under-represented or over-represented in the WHRS data.

Complete and accurate figures on the base population are not available but estimates of the population can be made from surveys. BRANZ carries out a quarterly survey of new buildings that gathers information on buildings design and components. The survey covers Auckland, Wellington and Christchurch regions and so can be used to set a national average. Reliable data is difficult to come by on building complexity within the base building population. A BRANZ survey carried out in September 2003 asked respondents to identify the risk features being incorporated into their new house from the Weathertightness risk poster produced by the WBSG. Although these categories are not directly compatible with the summary sheet headings used by WHR, some idea of the complexity can be gained. This survey (211 responses were received) also requested information on the eaves width on new buildings.

a) Cladding types

The large proportion of WHRS data containing multiple claddings appears to make it difficult to make an exact comparison with base population data. However, many buildings in the base population also contain multiple claddings. For example, 29% of brick veneer clad buildings currently being built in Auckland have a second cladding that is more than 10% of the cladding area.

For simplicity, the main cladding types in the WHRS have been counted both as the sole cladding and in all instances where they occur with other claddings. The numbers were then pro-rated back to 100% to reduce the effect of double counting. This data was then compared to the base data.

Figure 8 shows the WHRS cladding distribution alongside the base population.

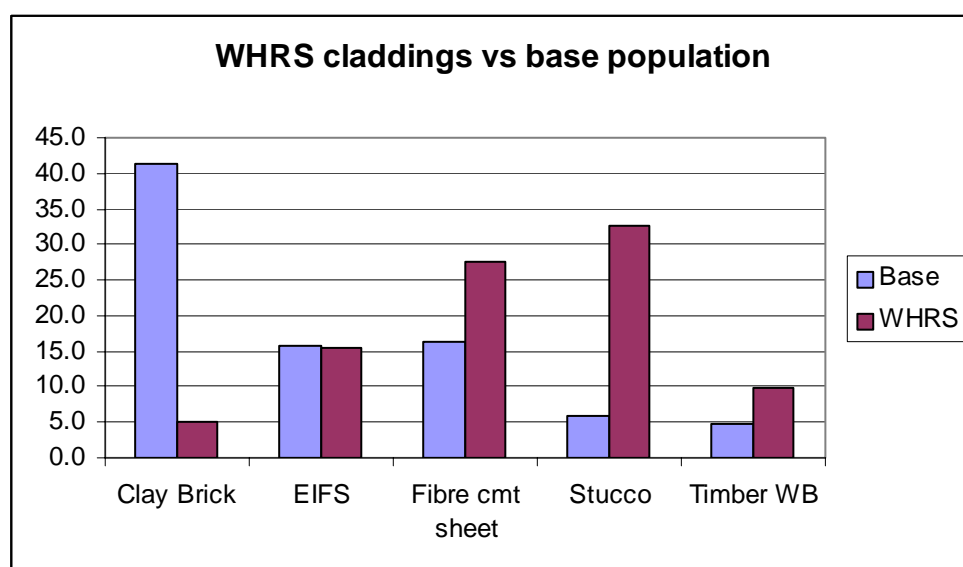


Figure 8: WHRS claddings versus base population

The main features of Figure 8 are that brick veneer is substantially under represented in the WHRS while stucco is substantially over represented.

b) Storey height

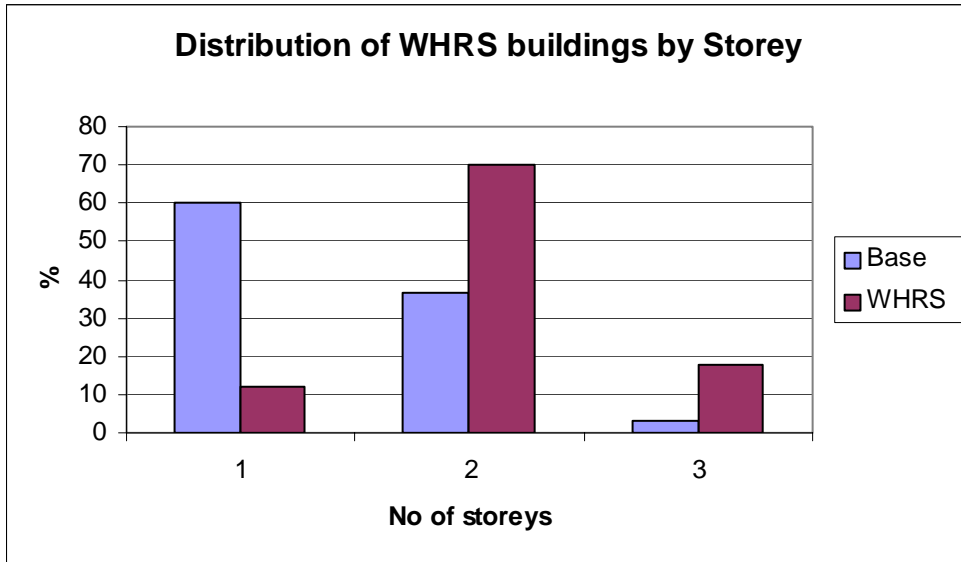


Figure 9 shows the distribution of storey height in the WHRS data versus the base population.

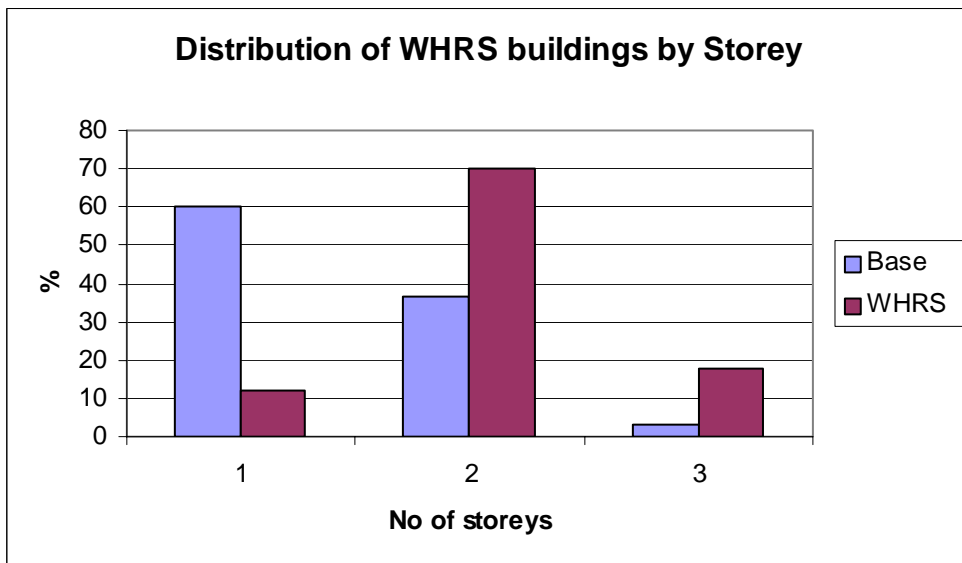


Figure 9: WHRS Storeys versus base population

c) Eaves width

Figure 10 shows the distribution of eaves widths in the WHRS data versus the base population.

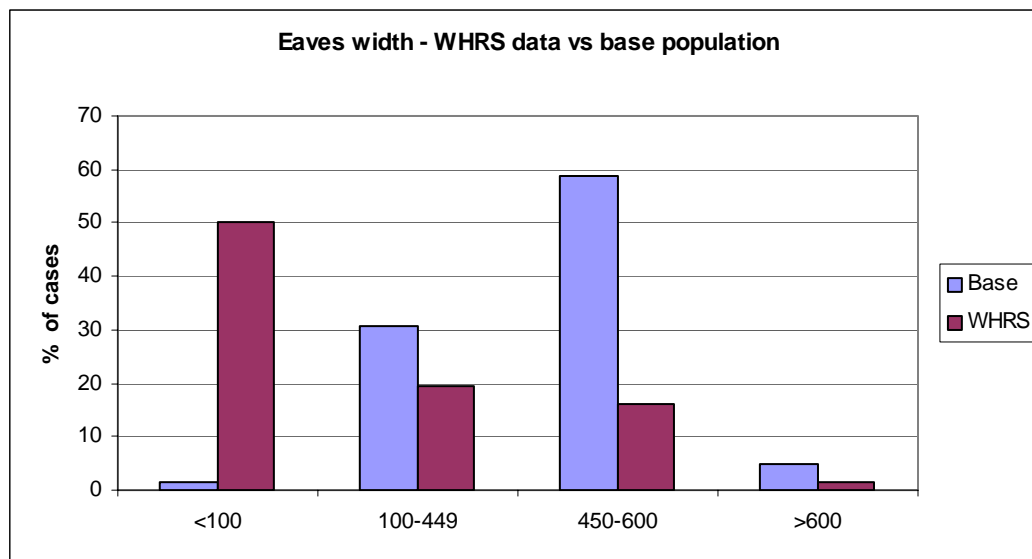


Figure 10: Eaves width - WHRS data versus base population

d) Decks and balconies

Of the buildings in the WHRS data, 74% had a deck or balcony. This compares to 13% in the base population

e) Complex Envelope shapes

Only 22% of the base population identified a total of four or more risk features on their building. In contrast, the WHRS data shows that 42% of the cases had either a complex or highly complex wall shape. For roofs, 37% of WHRS cases had complex roofs.

f) Multi-unit vs Standalone

Multi-unit dwellings make up 57% of the WHRS cases, whereas they comprise only 18% of the base population of units built over the last three years.

5 Input Parameters & Weightings for Risk Matrix

The data available from the reports together with site feedback generally supports the approach taken in the risk matrix proposed in the commentary to E2/AS1. However, it is considered appropriate to review both the parameters and their weightings as used for the E2/AS1 risk matrix.

It should also be noted that there may be a connection between different parameters which are associated with a higher incidence of leaks in buildings. For example, little or no eaves may be more common on buildings with monolithic claddings and decks and balconies. The number of cases in the data is currently too small to be able to distinguish such effects.

The practical test is that the risk matrix must accurately predict the actual recorded profile of buildings in the WHRS database. This is discussed later in this report.

a) Proposed revised risk matrix

The risk matrix divides critical design features of a building and its location into four risk categories and assigned scores to each of those, depending on the estimated risk involved in each of those elements.

A building is assessed by taking the relevant scores that are relevant to the particular design, and adding them to come up with a total risk score. That score is then used as the basis for determining the requirement for incorporating a drained cavity behind the particular cladding used in the design. Table 1 shows the risk matrix and Table 2 the claddings that can be used in the various categories of risk.

Examples of the scoring of different designs are given later in this report.

Risk Matrix

Risk Component	<i>Low</i>		<i>Medium</i>		<i>High</i>		<i>Very High</i>		
Wind zone (NZS3604)	Low	0	Medium	0	High	1	Very High	2	
No. of storeys	One	0	Part two storey	1	Two	2	More than two	4	
Roof type	Hip	0	Gable without eaves	1	complex shape/dormers	3	Multiple level, complex shapes or parapet	5	
Eave width (ignore if parapet)	Low risk	0	Medium risk	1	High risk	2	Very high risk	5	
Envelope complexity	Simple	0	Moderate	1	Moderately complex	3	Complex	6	
Decks/Balconies	Low risk	0	Medium risk	2	High risk	4	Very high risk	6	
Subtotals			+		+		+		
Total risk score								Total	

Definitions of risk:

Eave width	Low risk	Greater than 600mm at 1st floor level
	Medium risk	450mm - 600mm, or greater than 600 mm at 2nd floor level
	High risk	100mm - 449mm , or 450mm - 600mm 2nd floor level
	Very high risk	0 - 99mm , or 100-449 at 2nd floor level
Decks/Balconies	Low risk	None, or timber slat deck over subfloor only and attached at ground floor level
	Medium risk	Fully covered in plan by roof, or timber slat deck over subfloor only and attached at 1st or 2nd floor level
	High risk	Exposed in plan
	Very high risk	Exposed in plan and cantilevered

Table 1: Risk Matrix

Risk Score	Allowable Claddings
0-6	All claddings in E2/AS1 direct fixed or with cavity
7-12	Bevel back weatherboards, vertical profiled steel, vertical board and batten, or any cladding in E2/AS1 with a 20 mm minimum drained ventilated cavity or brick veneer
13-20	Vertical profiled steel, brick veneer or any cladding in E2/AS1 with a 20 mm minimum drained ventilated cavity
20+	Specific design

Table 2: Allowable claddings for various risk scores.

Key points of the revised matrix are:

Wind zone

The original matrix gave wind zone a substantial weighting, based on the theoretical considerations around wind driven water leaks. However, analyses of reports have shown no obvious relationship between wind zone and the incidence of leaks. It seems logical to argue that the incidence of gravity leaks via defects in the building envelope is swamping the effect of wind-blown leaks.

Taking this uncertainty into consideration, while wind zone has been retained in the risk matrix, the weighting given to it is less than that for those factors with a more reliable positive connection with leaks. Wind effects are therefore limited to high and very high wind zones and the weighting has been reduced.

Storey height

Storey height has been retained as a significant variable in the matrix.

Roof complexity

The E2/AS1 risk matrix is designed to establish what water management is needed behind wall claddings. Generally, roof leaks are less of an issue in this context than wall leaks. Minimum roof pitch is covered by the requirements of E2/AS1, and so is not included in the risk matrix.

However complex roofs frequently intersect with walls on upper floors, creating opportunities for leaks to penetrate directly into the wall. Defining a series of parameters to cover roof complexity is not a simple task but has been attempted in the risk matrix.

Wall complexity

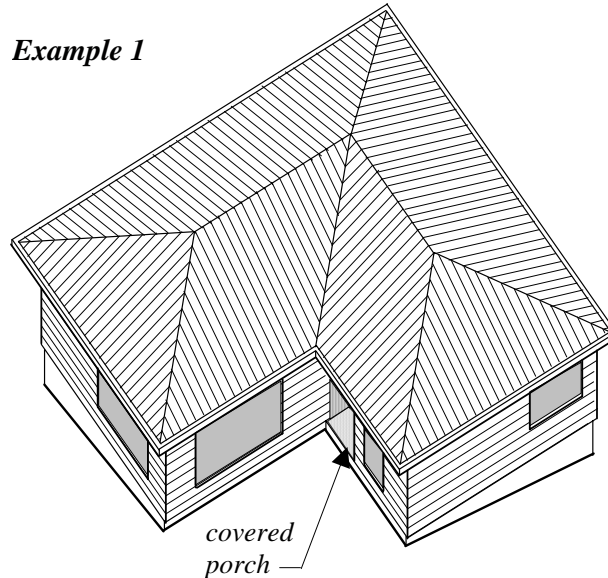
Wall complexity attempts to use the building form to define the effect on the risk of leaks of the number and difficulty of junctions and penetrations associated with the walls (but not expressly covered by decks/balconies). This factor has been retained in the risk matrix.

Decks/Balconies

Decks/balconies are present in 74% of the WHRS data but only 14% of the base population. Decks/balconies also provided the most frequent location for water leaks in the WHRS data. Decks and balconies have been retained as a significant factor in the risk matrix.

b) Examples using the Risk Matrix

The following diagrams illustrate how a score is derived for a variety of designs and cladding materials. In these examples, the end zone has been assumed to be high. The examples also show how a total risk score leads to particular requirements for different cladding types.

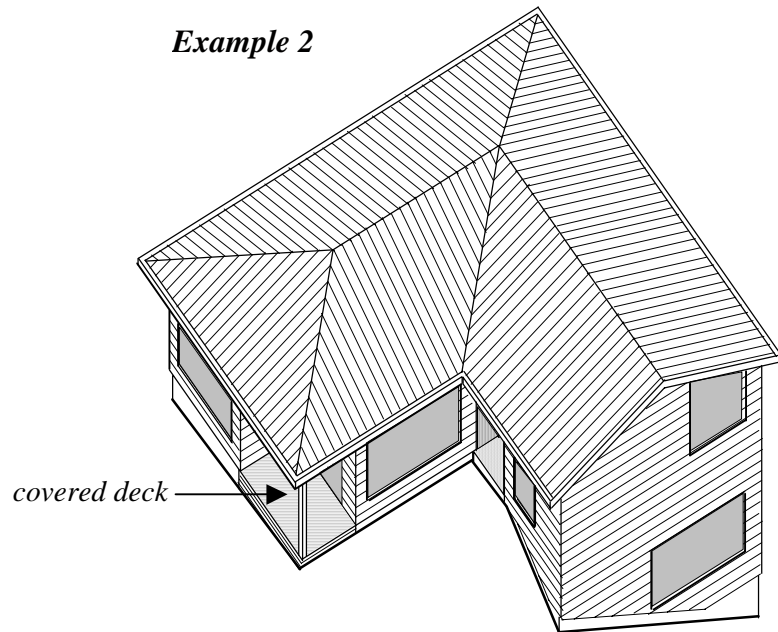


<i>Risk Score</i>	Low		Medium		High		Very High		
Wind zone (NZS3604)	Low	0	Medium	0	High	1	1	Very High	2
No. of storeys	One	0	Part two storey	1	Two	2		More than two	4
Roof type	Hip	0	Gable without eaves	1	complex shape/ dormers	3		Multiple level with complex shapes or parapet	5
Eave width	Low risk	0	Medium risk	1	High risk	2	1	Very high risk	5
Envelope complexity	Simple	0	Moderate	1	Moderately complex	3		Complex	6
Decks/ Balconies	Low risk	0	Medium risk	2	High risk	4		Very high risk	6
Subtotals		0	+	1	+	1		+	0

Total E2/AS1 Risk Score

2

Example 2

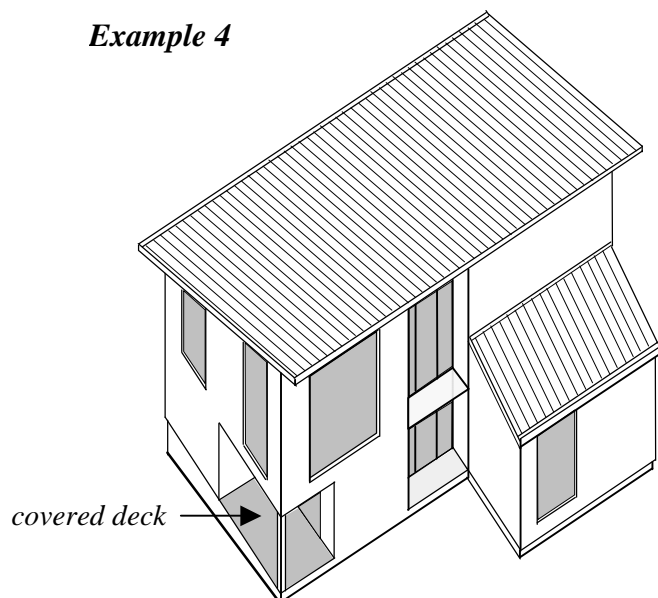


Risk Score	Low		Medium		High		Very High		
Wind zone (NZS3604)	Low	0	Medium	0	High	1	1	Very High	2
No. of storeys	One	0	Part two storey	1	1	Two	2	More than two	4
Roof type	Hip	0	0	Gable without eaves	1	complex shape/dormers	3	Multiple level with complex shapes or parapet	5
Eave width (ignore if parapet)	Low risk	0	Medium risk	1	1	High risk	2	Very high risk	5
Envelope complexity	Simple	0	Moderate	1	Moderately complex	3	Complex	6	
Decks/ Balconies	Low risk	0	Medium risk	2	High risk	4	Very high risk	6	
Subtotals		0	+	2	+	1	+	0	

Total E2/AS1 Risk Score

3

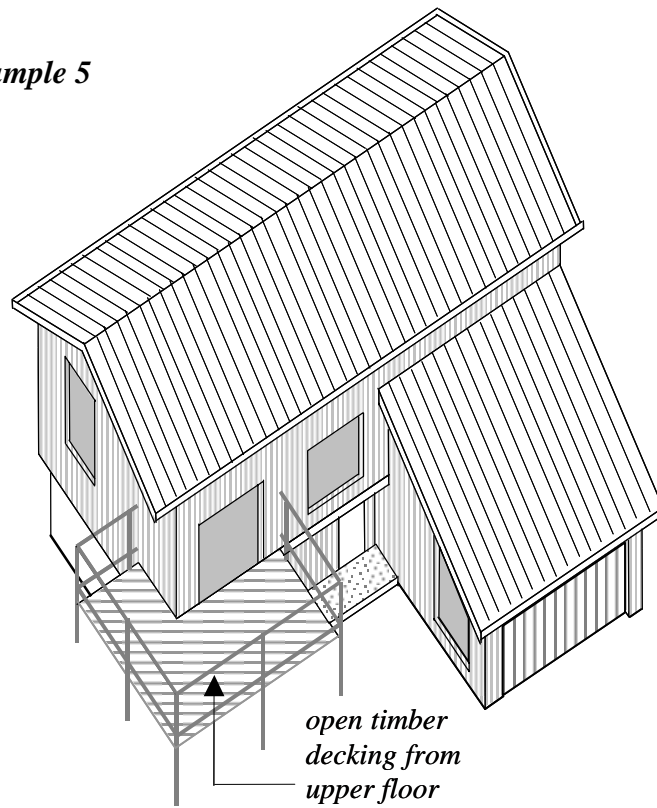
Example 4



Risk Score	Low		Medium		High		Very High		
Wind zone (NZS3604)	Low	0	Medium	0	High	1	1	Very High	2
No. of storeys	One	0	Part two storey	1	Two	2	2	More than two	4
Roof type	Hip	0	Gable without eaves	1	1	complex shape/ dormers	3	Multiple level with complex shapes or parapet	5
Eave width (ignore if parapet)	Low risk	0	Medium risk	1	High risk	2	Very high risk	5	5
Envelope complexity	Simple	0	Moderate	1	Moderately complex	3	3	Complex	6
Decks/ Balconies	Low risk	0	Medium risk	2	2	High risk	4	Very high risk	6
Subtotals		0	+	3	+	6	+	5	

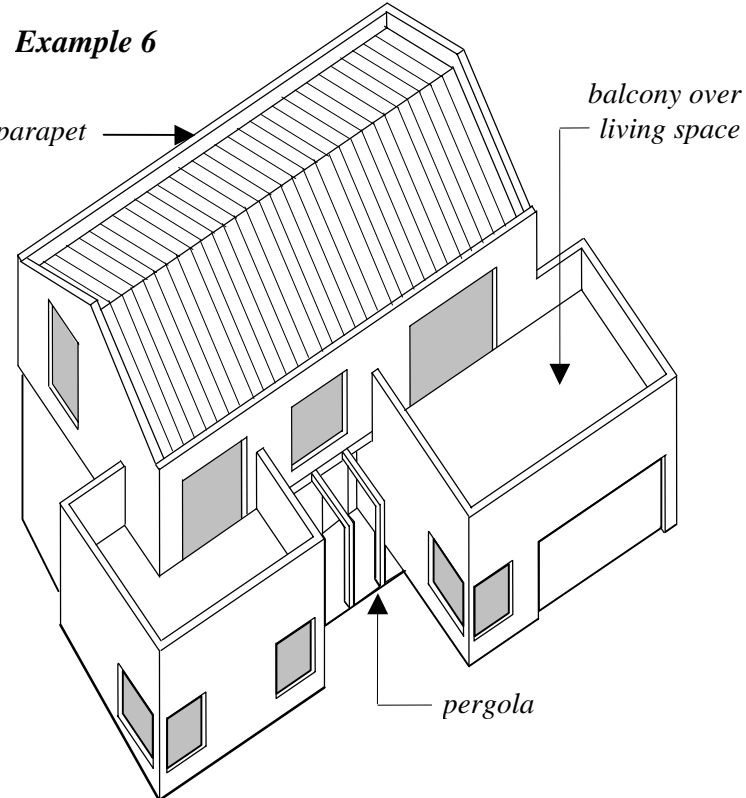
Total E2/AS1 Risk Score 14

Example 5



<i>Risk Score</i>	Low		Medium		High		Very High		
Wind zone (NZS3604)	Low	0	Medium	0	High	1	1	Very High	2
No. of storeys	One	0	Part two storey	1	1	Two	2	More than two	4
Roof type	Hip	0	Gable without eaves	1	1	complex shape/dormers	3	Multiple level with complex shapes or parapet	5
Eave width (ignore if parapet)	Low risk	0	Medium risk	1		High risk	2	Very high risk	5
Envelope complexity	Simple	0	Moderate	1	1	Moderately complex	3	Complex	6
Decks/Balconies	Low risk	0	Medium risk	2	2	High risk	4	Very high risk	6
Subtotals		0	+	5		+	1	+	5

Total E2/AS1 Risk Score 11



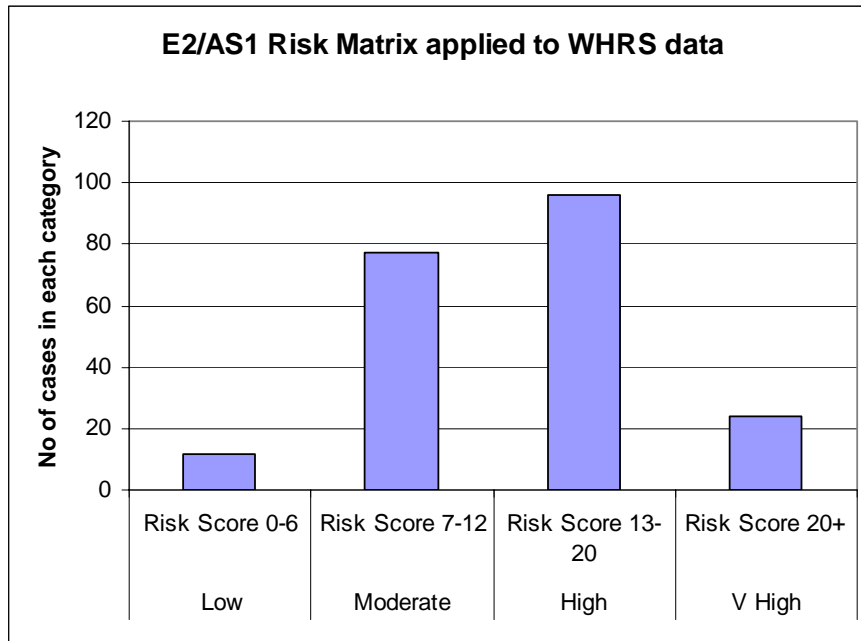
<i>Risk Score</i>	Low		Medium		High		Very High		
Wind zone (NZS3604)	Low	0	Medium	0	High	1	1	Very High	2
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Roof type	Hip	0	Gable without eaves	1	complex shape/dormers	3	5	Multiple level with complex shapes or parapet	5
Eave width (ignore if parapet)	Low risk	0	Medium risk	1	High risk	2		Very high risk	5
Envelope complexity	Simple	0	Moderate	1	Moderately complex	3	6	Complex	6
Decks/Balconies	Low risk	0	Medium risk	2	High risk	4		4	Very high risk
Subtotals		0	+	0	+	7	+	11	

Total E2/AS1 Risk Score 18

c) Comparison with WHRS data

The WHRS information was used in the revised risk matrix, and the resulting risk categories are shown in Figure 11:

Figure 11: WHRS data in risk matrix



The presence of low risk buildings showing up in the data may appear surprising at first. However, even relatively simple houses still require proper detailing of windows and junctions etc. Of the low risk buildings in the WHRS data, 7 leaked at window flashings, 2 leaked at internal gutters and 5 had cracks in cladding.

In the moderate risk group, most buildings were clad with either monolithic cladding or monolithic claddings in conjunction with another cladding. The major sources of leaks in this group were; cracks in the cladding system (47), window flashings (40), leaks in cap flashings (22), saddle flashings (13) and roof to wall junctions (9). Note that cracks in claddings can be a symptom of water entry as well as a cause. For example, water entering from a flashing defect will cause timber framing to get wet and expand. This in turn can stress the joints between claddings leading to cracks.

In the high-risk group, like the moderate risk group, most buildings were clad with either monolithic cladding or monolithic claddings in conjunction with another cladding. The main sources of leaks were located around balconies or decks with cap flashings (58), deck to wall junctions (38), cracks in cladding system (38), balustrade/parapet wall junctions (38) and fixing through cap flashings (26).

All houses in the very risk group had a monolithic cladding (one had EIFS and concrete block). The main locations of water leakage were; cracks in cladding system (20), deck to wall junctions (18), apron flashings (14) and wall to roof intersections (11).

6 Appendices

a) Summary of WHRS statistics as at 31 October 2003

Type of property	
stand alone	91
unit/apartment	91
apartment complex	29
	total 211
No of storeys	
single	25
split	8
2	137
>2	37
specific standards	2
unknown	2
	total 211
Wind exposure	
low	18
moderate	110
high	50
very high	26
specific standards	3
unknown	4
	total 211
Roof complexity	
simple monopitch/curve	26
simple gable/hip	104
complex shape/penetrations/dormers	34
multiple level with complex shape	42
unknown	5
	total 211
Roof slope	
flat	14
flat / less than 10 degree slope	18
flat / less than 10 degree slope / sloping	6
flat / sloping	20
less than 10 degree slope	24
less than 10 degree slope / sloping	11
<i>sloping (unspec)</i>	115
unknown	3
	total 211
Roof features	
skylights	31
dormer windows	12
skylights / dormer windows	9
n/a	1
unknown	158
	total 211
Roof eaves	
Width (mm)	

0	102
20	2
30	1
80	1
0-100	1
0-150	4
0-200	13
0-300	11
0-350	1
0-400	4
0-450	7
0-490	1
0-500	5
0-600	28
0-900	1
200-600	1
400-600	1
400-1000	1
500-800	1
unknown	25
total	211

7 Roof materials

asphalt shingles	6
concrete/clay tile	34
Concrete/clay tile; Other - Butyl membrane	1
fibreglass shingles	1
flexible sheeting/coating	8
flexible sheeting/coating / asphalt shingles	2
flexible sheeting/coating / concrete/clay tile	1
long-run metal	97
long run metal / concrete/clay tile	1
long run metal / concrete/clay tile / other - butyl rubber	1
long run metal / flexible sheeting/coating	26
long run metal / flexible sheeting/coating / timber shingles	1
long run metal / metal tile	3
long run metal / other - butyl rubber	1
long run metal / other - butynol gutters	2
metal tile	20
metal tile / flexible sheeting/coating	2
other - butyl	1
other - butynol	1
other - onduline	2
total	211

External wall cladding materials

brick/block veneer	2
brick/block veneer / textured fibre cement	5
concrete block/concrete	1
Concrete block/concrete; Textured fibre cement	1
EIFS	21
EIFS; Brick/block veneer	1
EIFS; Brick/block veneer; Textured fibre cement; Cladding changed from specifications?	1

EIFS; Cladding changed from specifications?	13
EIFS; Concrete block/concrete	1
EIFS; Textured fibre cement	1
EIFS; Untextured fibre cement; Cladding changed from specifications?	1
fibre-cement weatherboard	3
Fibre-cement weatherboard; Textured fibre cement	1
horizontal timber weatherboard	2
Horizontal timber weatherboard; Brick/block veneer	2
Horizontal timber weatherboard; Cladding changed from specifications?	1
Horizontal timber weatherboard; Other - plywood	1
Horizontal timber weatherboard; Stucco on flexible backing	10
Horizontal timber weatherboard; Stucco on rigid backer	1
Horizontal timber weatherboard; Textured fibre cement	7
Horizontal timber weatherboard; Untextured fibre cement	1
Other - Exopanel Structural Panels	1
Other - plywood & batten	1
Other - Polyblock	1
Profiled coated steel; Stucco on rigid backer; Other - Plywood	1
PVC weatherboards; Concrete block/concrete; Textured fibre cement	1
PVC weatherboards; Textured fibre cement	1
Stucco on flexible backing	6
Stucco on flexible backing; Cladding changed from specifications?	1
Stucco on flexible backing; Untextured fibre cement	1
Stucco on rigid backer	49
Stucco on rigid backer and cavity	3
Stucco on rigid backer; Brick/block veneer	2
Stucco on rigid backer; Cladding changed from specifications?	5
Stucco on rigid backer; Concrete block/concrete	1
Stucco on rigid backer; Stucco on rigid backer and cavity	1
Stucco on rigid backer; Textured fibre cement	1
Textured fibre cement	46
Textured fibre cement; Cladding changed from specifications?	3
Unknown	4
Untextured fibre cement	1
Untextured fibre cement; Cladding changed from specifications?	2
Vertical or diagonal timber weatherboard; Textured fibre cement	1
	total 210
Internal wall linings materials	
unknown	4
Paper-faced plasterboard	200
'Paper-faced plasterboard; Other - Wet Linings	1
'Paper-faced plasterboard; Timber	2
other - mdf	1
other - triboard	2
other	1
	total 211
Wall complexity	
simple box	37
simple shape > 4 corners	84
complex shape with many corners/junctions	81
highly complex shape with many corners/junctions	6
unknown	3
	total 211

Framing materials**floor**

kiln-dried UT	21
Kiln-dried UT; H1 Boron	3
Kiln-dried UT; H1 Boron; Unidentified	2
'Kiln-dried UT; H1 LOSP	1
H1 LOSP	4
H1 Boron	76
'H1 Boron; H3 CCA	1
H3 LOSP	1
H3 CCA	0
Douglas Fir	6
Macrocarpa	0
Larch	0
metal	0
Unidentified	84
'Other - Particle BD	1
Other - rimu	1
Other - Triboard (Solid wall panel)	3
unknown	7
total	211

walls

kiln dried UT	21
Kiln-dried UT; H1 Boron	3
Kiln-dried UT; H1 Boron; Unidentified	1
Kiln-dried UT; H1 LOSP	1
H1 LOSP	5
H1 Boron	78
H1 Boron; H3 CCA	1
H3 LOSP	1
H3 CCA	0
Douglas Fir	5
Macrocarpa	0
Larch	0
metal	0
Unidentified	83
other	5
Other - Particle BD	1
Other - rimu	1
Other - Triboard	3
n/a	0
unknown	7
total	195

roof

kiln-dried UT	21
'Kiln-dried UT; H1 Boron	3
'Kiln-dried UT; H1 Boron; Unidentified	2
'Kiln-dried UT; H1 LOSP	1
H1 LOSP	4
H1 Boron	76
H1 Boron; Douglas Fir	1
'H1 Boron; H3 CCA	1
H3 LOSP	1

Douglas Fir	6
Macrocarpa	0
Larch	0
metal	0
Unidentified	84
Other - Particle BD	1
Other - rimu	1
Other - Triboard Solid Wall Panel	3
n/a	0
unknown	6
	total 211
deck	
kiln-dried UT	2
H1 LOSP	1
H1 Boron	25
H1 Boron; Unidentified	1
H3 LOSP	1
H3 CCA	11
Douglas Fir	2
Macrocarpa	0
Larch	0
metal	0
Unidentified	67
other	0
n/a	75
unknown	24
Other - Triboard Solid Wall Panel	2
	total 211
balcony	
kiln-dried UT	2
H1 LOSP	1
H1 Boron	19
H3 LOSP	1
H3 CCA	6
Douglas Fir	2
Macrocarpa	0
Larch	0
metal	0
Unidentified	72
other	1
n/a	82
unknown	25
	total 211
Window materials	
aluminium	202
'Aluminium; Timber	4
timber	4
steel	0
UPVC	0
unknown	1
	total 211
Floor materials	
concrete	54

Concrete; Other - Timber - Intermediate	1
Concrete; Other - triboard	2
Concrete; Timber/Particle board	136
Timber/Particle board	13
unknown	5
	total 211

Location of leaks

penetrations, spouting into cladding	44
penetrations, hand rails	53
penetrations, other	24
cap flashings to balcony or parapet	84
fixings through cap flashings	45
flashings at horizontal control or inter-storey joints	26
apron flashings	58
cracks in cladding system	127
deck-to-wall junction	87
junction between different claddings	31
balustrade	39
balustrade or parapet into wall	68
balcony or pergola penetrations	31
wall-to-roof intersection	44
window flashings	103
membrane deck	21
membrane roof	29
internal gutters	25

Cause of water entering the house

design of house inappropriate or high risk	61
design of deck/balcony inappropriate	76
complex roof design	34
roofing incorrectly installed	50
plastering sub-standard	68
cladding sub-standard	32
manufacturer's instructions not followed	69
insufficient ground clearance	87
deck drainage insufficient	59
other drainage insufficient	34
inter-storey joints	24
control joints	63
penetrations	74
flashings inadequate or omitted, roof	53
flashings inadequate or omitted, door	49
flashings inadequate or omitted, window	88
flashings inadequate or omitted, balustrade	50
flashings inadequate or omitted, parapet	34

Damage

framing damaged	141
floor damaged	76
ceiling damaged	75
balcony damaged	71
internal wall linings damaged	131
deck-to-wall junction damaged	60

external walls damaged	106
carpets wet or rotting	79
structural failure imminent	47
joists damaged	43
mould present	104
stachybotrys identified	39
Remediation recommended	
full reclad	82
partial reclad	59
cladding repair	65
internal linings reinstated	128
roof repairs	71
roof drainage repairs	45
major framing replacement	33
minor framing replacement	86
install flashing (door/window)	100
upgrade balcony drainage	60
lower surface/raise balcony door	37
lower ground surface/provide drainage	34
flooring, replace carpet	29
flooring, replace flooring material	25
structural repair of balcony	46
balustrade repair	35
balustrade replacement	30
mould removal	40
other	8