

Determination 2019/067

Regarding the decision to grant a building consent subject to notification under section 73 and whether the land, which is adjacent a coastal estuary, is subject to a natural hazard at 117 Main Road, Redcliffs, Christchurch

Summary

This determination considers whether land adjacent a coastal estuary is subject to a natural hazard; the hazard being inundation by rising sea level and by surface water flooding. The applicants have built a house on the land under a building consent issued with section 73 condition. The house has been specifically designed to mitigate the potential effects of any flooding on the building and the land.

1. The matter to be determined

- 1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004 (“the Act”) made under due authorisation by me, Katie Gordon, Manager Determinations, Ministry of Business, Innovation and Employment (“the Ministry”), for and on behalf of the Chief Executive of the Ministry¹.
- 1.2 The parties to the determination are:
 - the owners of the property, M. S. Smart, R. M. Dalman and E. J. Chapman (“the applicants”)
 - Christchurch City Council (“the authority”), carrying out its duties as a territorial authority or building consent authority.
- 1.3 This determination arises from the authority’s decision to grant building consent for the construction of a house on the applicants’ property subject to a section 73² notice, on the grounds that the land on which the house was to be built was subject to a natural hazard (inundation). The applicants are of the view that the land is not subject to a natural hazard, and accordingly the provisions in sections 71 to 73 do not apply.
- 1.4 The matter to be determined³ is therefore the authority’s exercise of its powers in granting the building consent under section 72 of the Act making it subject to notification under section 73. In making this decision I must consider whether the land is subject to a natural hazard and section 71 of the Act applies.

¹ The Building Act and Building Code are available at www.legislation.govt.nz. The Building Code is contained in Schedule 1 of the Building Regulations 1992. Information about the Building Act and Building Code is available at www.building.govt.nz, as well as past determinations, compliance documents and guidance issued by the Ministry.

² Unless otherwise stated all references to sections are to sections of the Act and all references to clauses are to clauses of the Building Code. The relevant sections of the Act are set out in Appendix A.

³ Under sections 177(1)(b) and 177(2)(a) of the Act.

- 1.5 In making my decision, I have considered the submissions of the parties, the report of the independent expert commissioned by the Ministry to advise on this dispute (“the expert”) and the other evidence in this matter. I have not considered any other aspects of the Act or Building Code, beyond those required to decide on the matter to be determined.
- 1.6 The relevant sections of the Act referred to in this determination are set out in Appendix A; the natural hazards decision tree is shown in Appendix B.

2. The building work

- 2.1 The applicants are in the process of building a house on their property in an urban area of Christchurch. The property (Lot 72, DP 1178) is a long narrow site that runs between the road and the outlet channel from the Avon-Heathcote Estuary to the coast.
- 2.2 The applicants have obtained resource consent for land reclamation and construction of a seawall. They have undertaken extensive geotechnical, structural and civil engineering investigations in relation to the property and, with the authority’s input, specifically designed the building work to prevent and cope with potential effects of inundation, and to mitigate any impacts it might have on the building and land.

2.3 The seawall

- 2.3.1 The applicants obtained building consent, No. BCN/2018/4669, to build a stepped two-level specifically-designed seawall located approximately 2.7m back from the property’s boundary on its estuary (eastern) side, as well as for some land reclamation and consolidation work to raise the lower part of the site immediately behind the seawall. Work to the seawall comprised 300mm diameter SED⁴ timber poles, precast concrete panels, rock armour and engineered fill. At the time of the application for a determination, the work associated with the seawall was almost complete.
- 2.3.2 Based on current levels at high tide, the estuary boundary will be underwater, with the water reaching the base of the seawall.
- 2.3.3 The top of the seawall has a reduced level (RL)⁵ of 11.4m. The seawall runs along the entire estuary side of the applicants’ property. It is flanked on its southern side by seawalls constructed on the neighbouring properties. To the north, some of the neighbouring properties are still being developed, meaning there are only intermediate seawalls and rock rip-rap in this direction.
- 2.3.4 The consented plans for the building work show an existing seawall and a ‘proposed neighbour’s seawall’ on the property immediately to the north which the parties advise has been partially demolished. The applicants advise that the owner of the neighbouring property is in the process of rebuilding the wall and is liaising with the applicants about this. The authority advises ‘no consent for a replacement wall [on the neighbouring property] has been ... granted’.

⁴ Small end diameter, being the nominal diameter of the smaller end of the post

⁵ Reduced level (RL) – the vertical distance between survey points and with reference to a common assumed datum

2.4 The ground and surface water drainage

- 2.4.1 The structural integrity of the ground over the site has been enhanced by increasing its density and raising its level, so that it now slopes from RL 11.20m at the road end to RL 11.10m at the estuary end. The applicant advises that any depressions on the site that would have allowed ponding under the house have been removed.
- 2.4.2 The applicants have installed a comprehensive surface water removal system, comprising a number of sumps, strip drains, preferential flow paths, and three 100mm diameter drains with non-return valves through the seawall to the estuary. At the road-end of the property, the surface water system drains to the authority's utility network; at the estuary-end, it drains through the non-return valves to the estuary.

2.5 The house

- 2.5.1 The house is presently under construction. The house is set back approximately 3.9m from the top of the seawall, and approximately 8m from the estuary boundary. The house takes up most of the remainder of the site. The house is predominantly single-storey with guest accommodation at first floor level over a garage to the road-end of the site, and a first floor master bedroom suite and storage to the estuary-end.
- 2.5.2 A deck extends from the house's eastern side to the boundary, and at high tide will extend out over the water. There are decks to the central portion of the house.
- 2.5.3 The house itself sits approximately 1.3m above the ground level, having a ground floor RL of 12.36m. The house has a 300mm reinforced concrete slab foundation on 200mm base course to form the building platform. The house is constructed on an elevated timber-floor above this, so that the house and its decks in effect sit on a suspended platform. The house floor is mainly supported on treated-timber piles, which are embedded into the concrete slab, except in a small portion of the house where the floor rests on filled concrete blocks connected to the concrete slab.
- 2.5.4 The space between the slab and the floor is enclosed by a sub-floor façade made up of treated timber slats, fixed horizontally with a space between each slat. The intention of this design is that any water that enters the site can flow freely beneath the house and through to the estuary, without adversely affecting the slab or the piles. The entry steps to the house and its front deck have similarly been designed to allow water to flow beneath them.
- 2.5.5 The garage, which is located at the road-end of the property, has a concrete floor slab and two garage-type doors (one on the road-side and one on the estuary-side, respectively 5.0m and 2.3m wide). The garage has been constructed at RL 11.23; all electrical points, joinery and built-in fittings are located above RL 12.36m.
- 2.5.6 The work in question is described in Figures 1 and 2 which show the site and a longitudinal section though the seawall and the house to the north east of the site.

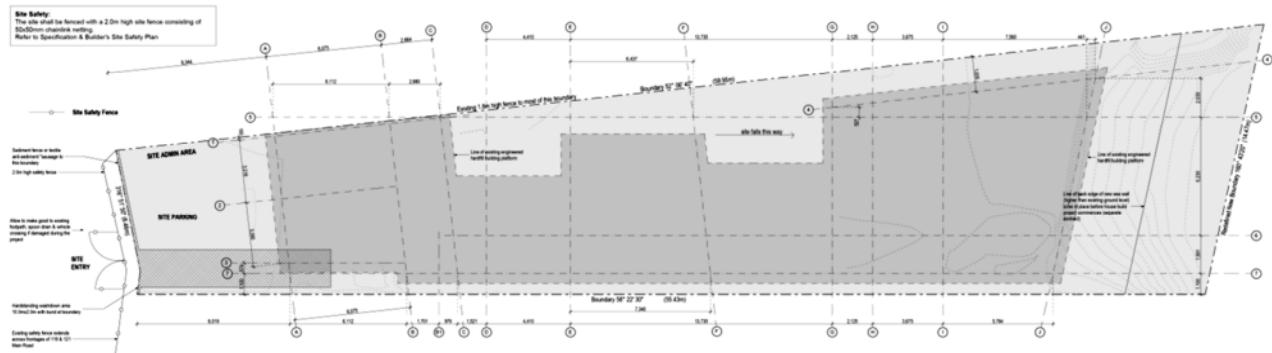


Figure 1: The site layout showing the building in outline (taken from the consented drawings, not to scale)

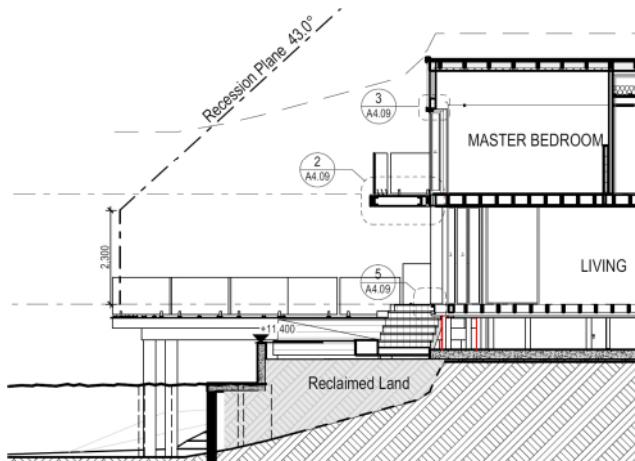


Figure 2: Section through the house and seawall (taken from the consented drawings, not to scale)

3. The background

- 3.1 The applicants advise that they worked closely with the authority’s resource consent, flooding, and building teams throughout the consent process. However, they were not aware that the authority still considered their property was likely to be subject to inundation until they applied for a building consent to construct the house.
 - 3.2 At this point, the authority advised the applicants that during a 2% annual exceedance probability (AEP)⁶ flood there was potential for their entire property to flood to a depth of 200mm to 300mm, and that it did not consider that allowing flood water to flow under the building was ‘an appropriate form of mitigation’ or that adequate provisions had been made to protect the land from inundation. The authority considered it appropriate for the building work to go ahead under section 72, with a notice pursuant to section 73 (“the section 73 notice”) registered against the certificate of title for the property.
 - 3.3 On 26 September 2018, the applicants signed a ‘Building Act 2004, sections 71-74’ form acknowledging that their building consent would be issued subject to a section 73 notice.

⁶ Annual exceedance probability (AEP) – the probability of an event occurring annually. 2% AEP means an event has a 2% probability of occurring annually and is commonly referred to as a 1-in-50 year event; a 1% AEP means an event has a 1% probability of occurring annually and is commonly referred to as a 1-in-100 year event.

- 3.4 On 2 October 2018, the authority issued a building consent (BCN/2018/4964) for the ‘Construction of a dwelling with attached garage subject to section 73 notice’. In issuing the building consent, the authority accepted the proposed work was compliant. However, the authority issued the consent with the condition that it would be subject to notification under section 73(1) in respect of the natural hazard inundation pending the outcome of this determination.
- 3.5 The applicants advise that, although they did not agree that the land was subject to inundation, they wished to proceed with the building work. The condition on the consent enabled them to start work while the inundation issue was resolved.
- 3.6 The applicants applied for a determination and this was received by the Ministry on 31 October 2018.

4. The submissions

4.1 The applicants’ initial submissions

- 4.1.1 The applicants made a submission with their application for a determination, in which they set out their position that:
- the property is not subject to inundation either from rainfall or sea water
 - they had ‘more than adequately protected the land and building platform’ from any potential rainfall or coastal water that may enter the property
 - as a result, there should not be a section 73 notice registered against the title.
- 4.1.2 In their submissions they refer to:
- a 2012 document prepared by the Ministry following the Canterbury earthquakes⁷ to provide guidance to building consent authorities on the interpretation and application of sections 71 to 74 of the Act, including building on land that was potentially subject to inundation (“the Ministry Guidance”)⁸
 - two previous determinations that had considered the application of sections 71 to 74 – determinations 2017/048⁹ and 2017/080¹⁰.
- 4.1.3 On 8 November 2018 the Ministry wrote to the parties requesting further information relating to the anticipated levels of inundation on the applicants’ property in a 1% AEP flood event.
- 4.1.4 The applicants responded on 9 January 2019 advising that in the period since the application for determination had been made, they had received expert advice from a firm of specialised engineering consultants (“the applicants’ expert”) and received a flood inundation assessment for their property, which they referred to in their submission (the assessment itself was not provided). The applicants made a further submission on 24 January 2019 in response to the authority’s submission dated 11 January 2019. The main points from the applicants’ submissions are as follows.

⁷ The Canterbury Earthquake Sequence includes the ‘Darfield Earthquake’ of 4 September 2010 with a moment magnitude of 7.1, followed by a series of aftershocks that included a 6.3 magnitude shake on 22 February 2011.

⁸ Ministry of Business, Innovation and Employment. Guidance to CERA and Canterbury building consent authorities to repair and rebuild houses on land potentially subject to inundation, particularly with respect to the application of Section 71 to 74 of the Building Act 2004 (11 September 2012).

⁹ Determination 2017/048: Regarding the decision to grant a building consent subject to notification under section 73 for building work on land subject to a natural hazard (30 June 2017).

¹⁰ Determination 2017/080 The granting of building consent for alterations to an existing building subject to notification that the land is subject to a natural hazard (13 November 2017).

Rainfall inundation

Level of inundation	<ul style="list-style-type: none"> The authority advises that in a 1-in-50 year rainfall event the predicted water level will be RL 11.41. This calculation is based on Christchurch Drainage Datum. The authority considers there is potential for inundation of 200mm to 300mm across the applicants' property during a 1-in-50 year flood. This is less than the Ministry Guidance, which accepts that flooding of less than 400mm, with a flow velocity of less than 1m per second, and of a brief duration, during events in a 1% AEP event is not inundation. It is also less than the levels considered in determinations 2017/048 and 2017/080. The authority also identifies flooding of below 400mm as 'minor' in its Infrastructure Design Standards. The provision for surface water drainage on the road near the applicants' property is poor and needs to be addressed by the authority. The applicant has seen no evidence that flooding was observed on their site during the March 2014 rainfall event.
Velocity of flow	The applicants' expert considers that the flow path of any rainwater inundation, from the road reserve and across the applicants' property, will not generate high velocity flows and is likely to be less than the 1m/s identified in the Ministry's Guidance as the threshold for an inundation natural hazard.
Removal of inundation	<ul style="list-style-type: none"> Any rainwater entering the site will dissipate quickly, via the strip drains and sump, to the authority's surface water system at the road, or through the non-return valves into the estuary. In the 'extremely unlikely' event of floods higher than RL 11.4m, the water could flow over the top of the seawall into the estuary. Occasional water on the site does not constitute inundation. If there was sufficient flooding on the road for passing cars to generate wave action, then the road is likely to be closed. Such action would not, in any event, reach the floor level of the house. The likelihood of there being ankle-deep water on the site, as alleged by the authority, is minimal because of the slope of the site and the return valves.

Seawater inundation

Duration of high sea levels	<ul style="list-style-type: none"> If the level of the sea, due to storm surge and sea level rise, is higher than the non-return valves in the seawall, this will last for 'a maximum of only 1–2 hours before the tide turns and the water level lowers'. This cannot be defined as inundation. Data for extreme sea levels taken at Ferrymead tide gauge during 2017 and 2018 shows that the duration of high water levels (at peak high tide) is just over 1 hour during a 1% AEP event.
Location for measuring tidal water level data	<ul style="list-style-type: none"> The applicants' expert considers that the 'most accurate and appropriate' tidal water level data for the applicants' property should be measured at Ferrymead tide gauge, due to its proximity. The authority's predicted extreme sea level of 10.91m is based on a 2% AEP extreme sea level event, and is measured at Bridge Street tide gauge. The applicants' expert advises this is not the correct location to measure levels for the applicants' property due to distance, data variation and coastal geography.
Damage from inundation	Any damage caused by high sea levels would be restricted to soft landscaping and minor.

Protection of the land

Protective measures	<ul style="list-style-type: none"> The applicants have taken extensive geotechnical, structural and civil engineering, and architectural measures to protect the house and land and mitigate flooding risks. The site levels allow for an even flow of water from the road to the estuary. The design encourages water to flow down the sides of the house. It would only be a larger flood that the water may also flow under the house.
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Structural integrity of the land	The structural integrity of the land has been increased through earthworks (to increase the density), the sea wall (to prevent erosion) and the concrete slab (to create a secure building platform for the house).
Construction of the seawall	<ul style="list-style-type: none"> The seawall is engineer-designed and has resource consent and building consent. For the purposes of these consents, the issuing authorities considered the seawall 'more than adequate to cope with storm tide/surge and projected sea rise'. This earlier building consent was not subject to a section 73 notice. At a height of 11.4m, the seawall is sufficient to protect the land from a combination of high tide, storm surge and potential sea level rise. The design of the seawall enables it to be made even higher, should this prove necessary in the future.
Non-return valves	The three non-return valves in the seawall are set at a RL 11.125m, and are of a 'commercial grade' designed for flooding situations.

Protection of the buildings

Design and integrity of the subfloor	<ul style="list-style-type: none"> The subfloor concrete pad provides a secure building platform for the house, and will ensure that even if the land is flooded the structural integrity of the house will remain intact. The subfloor area of the house is designed to allow water to flow through it, without affecting the concrete slab or piles. It was the authority's engineers who first suggested this solution.
Consented levels	<ul style="list-style-type: none"> At the time of the consent, the authority required a minimum floor level for the house of RL 11.81m and a minimum building platform level of 11.41m. These levels included an allowance for a 500mm sea-level rise, and were stated by the authority to provide adequate protection for the land and buildings from 'the inundation hazard'. The applicants' site and floor levels comply with these levels.
Floor level of the house – RL 12.36m	<ul style="list-style-type: none"> The house floor level is 'significantly higher' than the land, and will be 'comfortable' and 'safe' during an extreme weather event. It is also well above any predicted flood levels or sea level rise, or combination of these, so there will be no damage to the house or its contents.
Garage design	The garage is designed so that water will not pond in it, and will flow through it, without any potential of flood damage.
Potential damage in a flood	The only potential damage to the buildings or land during an inundation event will be to the 'soft landscaping' and some possible sludge in the garage: 'such damage is less than minor and easily coped with once in every 50 years.'

Levels during a 1% AEP event

Extreme sea levels during a 1% AEP event	<ul style="list-style-type: none"> The predicted 1% AEP extreme sea level, for water levels at Ferrymead tide gauge, taking into account both 'high astronomical tide and storm surge' is 10.894m. This level includes hydraulic effects as the tide comes into the estuary and wave/wind set-up effects. River flows in the Avon and Heathcote Rivers will have no significant effect on estuary water levels. This level is well-below the applicants' building platform level of RL 11.21–11.23m. It is 'grossly unfair' for the authority to now assess the house using sea levels calculated using new data. The approved levels used for the building consent should be used. Even if the authority's new level of RL 11.64m is used, the tide level would only exceed the top of the sea wall for one hour, and would drain away after two hours. Allowance for freeboard has already been included in the actual water level data.
Impact of predicted sea level rises	<ul style="list-style-type: none"> Ferrymead is a more appropriate tide gauge to use than Bridge street, which is on the other side of the estuary. The tide level readings from Ferrymead are also likely to be more accurate as data has been collected there for longer. Even when the predicted extreme sea level at Ferrymead tide gauge is combined with the predicted sea level rise, this will not be enough to overtop the sea wall: $10.89 + 0.5 = 11.39m$. If the alternative Bridge Street tide gauge data is used, the wall will be overtopped:

	<p>$10.934 + 0.5 = 11.436$. However, such a scenario is unlikely to occur within the next 30 to 50 years (until the sea level rises), and then will only happen at the most annually and only last for an hour.</p> <ul style="list-style-type: none"> • Regardless of which data is used, the finished floor level will be well above any potential inundation at RL 12.36m, and the building platform will only experience flooding between 194mm and 294mm (using Ferrymead tide gauge data during a 1% AEP event), or 236 and 336mm (using Bridge Street tide gauge data). These levels are well within the 400mm cited in the Ministry Guidance.
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4.1.5 With their submission, the applicants provided copies of:

- plans for the building work
- correspondence between the parties
- guidance from the authority on flood risks and floor levels
- photos showing the location of their property
- the Ministry's Guidance.

4.2 The authority's initial submissions

4.2.1 The authority responded to the Ministry's request for information about 1% AEP data in emails dated 29 November and 3 December 2018.

4.2.2 The authority confirmed that at the time that the applicants' building consent was issued, it calculated the 1% AEP extreme sea level for the applicants' property to be RL 11.44m. However, since that time the authority had received an updated analysis of extreme sea levels from a consultant hydro scientist ("the authority's expert"). The authority's expert's report¹¹, dated 24 July 2018, updated the previously available data on extreme sea levels (the previous analysis had been conducted in 2011) to include more recent extreme sea level events.

4.2.3 Based on this analysis, the authority now considered the 1% AEP extreme sea level for the applicants' property to be RL 11.64m. Both the original and the updated levels included a 500mm allowance for a 50-year predicted sea level rise. However, the authority considered it arguable that this should be increased to 1m, to reflect 100 years of predicted sea level rise (this stance appears to arise from the analysis of more recent extreme events). The authority confirmed that both the original and updated levels had been based on data from the Bridge Street tide gauge monitoring location.

4.2.4 The authority then made a submission dated 11 January 2019 in response to the application for a determination.

4.2.5 In its submission, the authority referred to Determination 2017/048 and the 'natural hazards decision tree' in its Appendices¹². Based on that decision tree the authority considered there were two key questions:

- Is the land on which the building work will be carried out subject or likely to be subject to a natural hazard? (Section 71(1)(a))
- Has adequate provision been made or will be made to protect the land and building work from the natural hazard? (Section 71(2)(a))

¹¹ Goring, G. (2018). *Extreme sea levels at Christchurch Sites: EV1 Analysis*. Christchurch: Mulgor Consulting Ltd.

¹² The natural hazards decision tree is a tool developed by the Ministry to help guide authorities and other interested parties through the provisions in sections 71 to 74 of the Act, see Appendix B.

4.2.6 The main points from the authority's submissions on these two questions are as follows:

Is the land on which the building work will be carried out subject or likely to be subject to a natural hazard?

What is the land on which the building work will be carried out	<ul style="list-style-type: none"> Taking into account the decision in <i>Auckland City Council v Logan</i>¹³, the land on which the building work is to be carried out should be considered the whole of the applicants' property, because it is a small suburban site.
Whether inundation is 'likely'	<ul style="list-style-type: none"> Due to sea level rise, the magnitude of a 1% AEP event is different now to what it will be in the future. The authority takes 50 years of anticipated sea level rise, which it calculates as 500mm, into account when considering whether inundation is 'likely'. At present the 1% AEP level for the applicants' property is RL 11.14m, and inundation is not likely 'within a short timeframe'. Over the life of the building the likelihood will increase, and in 50 years, the 1% AEP level will be RL 11.64. This figure is based on 'the latest tidal statistical analysis'. Based on the information available when the consent was granted the level in 50 years' time was calculated as RL 11.44m. These figures do not include freeboard¹⁴ so the actual depth of inundation may be greater. The RL of 11.41m cited in much of the authority's communications is the 2% AEP level for the applicants' property. This was used because the 1% AEP data was not available and the authority considered that a hazard notice was required even at the 2% AEP level. As an alternative assessment, the authority calculated the likelihood of a 1% AEP event occurring within the 50-year life of the building. Based on this assessment, the applicants' property would still be submerged during a flood event, so even using the alternative assessment, the decision to issue the section 73 notice was correct.
Whether inundation constitutes a hazard	<ul style="list-style-type: none"> The authority accepts that varying degrees of inundation may be considered a hazard, depending on the location of the part of land that is inundated, and whether that land needs to remain flood-free for the property to remain in normal use. The authority expects that 'there will not be flooding under the building, and that there will be a platform around the building that will allow for normal egress and regress.' The size of this platform is to be considered on a case by case basis. Beyond this platform the authority accepts that inundation may have less impact on the normal use of the land, so that a water depth up to 400mm may not be a hazard, provided it is not fast flowing. People should be able to access their buildings and primary parts of their land without encountering a hazard. The authority does not accept that a suspended platform or deck protects the land from a hazard. A shallower depth of water over the entire site may present a greater hazard, than a site that has differing depths of water. On the applicants' site, there will only be very limited parts of it that are not accessed during normal use.
Duration of flooding	The authority accepts that any coastal inundation will be cyclical, with the tides. However, rainfall inundation may also affect the site, and if combined with coastal inundation will last longer.
Location for measuring tidal water level data	<ul style="list-style-type: none"> The authority considers the Bridge Street tide gauge is the best place to measure tidal water levels for the applicants' property; it is also within the estuary, on the same side as the applicants' property, and 'likely to be similarly affected by it'. The Sumner tide gauge is in open water and the Ferrymead tide gauge is on the opposite side of the estuary. During a storm, with winds predominating from the south or south-west, water levels on the Bridge Street / applicants' property side of the estuary will be higher than at Ferrymead. The latest tidal data shows there is little difference (25mm) between the water levels at the various locations.

¹³ *Auckland City Council v Logan* [1/10/99, Hammond J, HC Auckland AP77/99].

¹⁴ Freeboard is an additional dimensional allowance added to the inundation depth to allow for the effects of wave action.

Predicted sea level rises	The predicted sea level rise of 500mm over 50 years is based on data from Summer and Bridge Street tide gauges, which show an average increase in annual maximum high tide of 10mm/year.
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Has adequate provision been made or will be made to protect the land and building work from the natural hazard?

The requirement to protect	<ul style="list-style-type: none"> The building work complies with the Building Code, and the house has been adequately protected from the inundation hazard. The question is therefore whether the land has been adequately protected. Protection of the land is broader than just protecting the land from physical damage.
Whether the seawall protects the land	<ul style="list-style-type: none"> The seawall only provides some protection on the property's estuary boundary. It is primarily a retaining wall to prevent erosion, rather than flood protection, and does not protect all of the boundaries. Likewise, the slab under the house will protect the land from erosion but will not prevent inundation under the building. The height of the fittings etc in the garage is to comply with the Building Code but will not protect the garage from inundation. Clause E1.3.2 does not apply to garages. But the area outside the garage should be at a level to avoid an inundation, so people don't have to walk through water to get to the door.

4.2.7 With its submission, the authority provided copies of:

- the building consent
- the authority's expert's report.

4.2.8 On 15 April 2019, the authority also provided:

- a 'Storm Report' prepared by the authority in relation to an inundation event that flooded the Heathcote River from 11 to 13 October 2000.
- photos and rainfall data relating to an inundation event in the vicinity of the applicants' property from 3 to 5 March 2014.

4.2.9 An email accompanying the information indicated that the October 2000 event had a maximum return interval of about 1-in-40 years (2.5% AEP) for a 15-hour duration; while the March 2014 event had a return interval of about 1-in-250 (0.4 % AEP) years for a 24-hour duration. The email also noted that the analysis was for today's rainfall densities and does not include the additional 16% that the authority would use in 'designing for future climate change'.

5. The expert's report

5.1 General

- 5.1.1 As mentioned in paragraph 1.5, I engaged an independent expert to assist me in this matter. The expert is a technical specialist in hydrology and geomorphology, with more than 40 years' expertise in these fields, including flooding, erosion and natural hazards.
- 5.1.2 The expert provided a report dated 11 June 2019 which was provided to the parties for comment on 12 June 2019. In preparing the report, the expert assessed the available documentation, conducted a site visit at the applicants' property on 12 April 2019, and held discussions with the parties.

- 5.1.3 During the site visit, the expert confirmed the following elevations for the site and buildings (the expert noted that, according to the applicants, the initial ground level of the property was raised prior to the start of construction and actual levels may be higher than those given in the building consent documentation).

Site or building feature (taken from approved consent drawings)	Elevation (RL in metres)
Main Road, Redcliffs (adjacent to property)	11.17-11.28
Site – ground level	11.20-11.10
Garage slab	11.23
House ground floor level	12.36
Top of the seawall	11.40

- 5.1.4 In his report, the expert noted that inundation of the applicants' site could potentially come from three different sources:
- flooding of any streams and water courses in the vicinity (fluvial flooding)
 - flooding caused by intense rainfall and failure of any surface water management system (pluvial flooding)
 - flooding caused by high sea levels, including 'king tides' and sea level rise.

5.2 Fluvial flooding

- 5.2.1 With respect to fluvial flooding, the expert noted that as there were no permanent streams or watercourses near the applicants' property, the site was unlikely to be subject to 'direct fluvial flooding' unless any nearby drainage features became blocked during extreme rainfall events. Any potential inundation is therefore likely to come from 'direct precipitation on the site, runoff and poor drainage from adjacent sites, high water levels in the estuary, or a combination of these factors'.

5.3 Pluvial flooding

- 5.3.1 With respect to the rainfall information provided by the authority, the expert noted that for the October 2000 flood event, it is likely that none of the applicants' property would have been flooded, and that even the lowest ground level on the property would have been 100mm above the maximum flood level. For the more extreme March 2014 event, while the lower (estuary) end of the applicants' property experienced some flooding, the higher (road) end remained above the flood level, making it 'likely therefore that even during this event, safe access would still have been possible to the garage, and certainly to the house'. Any flooding would have been 'relatively shallow' and slow moving. This event had an annual return incidence of 250 years (0.4% AEP), and hence would have had greater water levels, depths and flooding extent than a 1% AEP event. In addition, the applicants have raised the ground level of their property since this event.

- 5.3.2 The expert concluded that:

...the [applicants'] property will not be subject to a significant depth of either fluvial or pluvial flooding, and resulting inundation, during the critical 1% AEP ... design event. Any flooding is likely to be from the residual risk caused by the blockage or failure of the [surface] water system. Safe access will still be possible to the garage, and certainly to the house.

5.4 Coastal flooding

- 5.4.1 With respect to the issue of which tide gauge was the most appropriate for estimating coastal water levels at the applicants' property, the expert noted that the 2011 earthquake in Canterbury had caused significant changes to the bathymetry¹⁵ of the Avon-Heathcote estuary, and that as a result the existing records 'may not be suitable for predicting future behaviour and water levels' in the estuary. In the expert's opinion:
- neither the Ferrymead nor Bridge Street tidal gauge is likely to be representative of the water levels at [the applicants' property]. This is because of extra influences experienced by these gauges not present at the estuary mouth, and their inability to measure waves entering the estuary and the associated nearshore effects.
- 5.4.2 Instead, the expert considered the third tide gauge located at Sumner Head should be used. The expert said:
- The water levels at Sumner Head may be more conservative (i.e. higher) than those at Ferrymead or Bridge Street because of the inclusion of open-water waves. Nonetheless, the long-term records of water level should be more representative of the study area, as the conditions at the entrance of the estuary during a high tide storm are likely to be more like the open coast environment (with some wave energy dampening).
- 5.4.3 With respect to the issue of how best to derive the design water levels for the applicants' property, the expert noted that a range of methods can be used to predict the AEP of 'extreme still water sea levels'. Using the empirical simulation technique (which the expert considered most appropriate in this situation) and the water level records from the Sumner Head tide gauge, the expert calculated that:
- The design water level for a 1% AEP ... event at the applicant's property, under the current environment, and not allowing for any sea level rise, is therefore RL 10.913m. This is 0.187m lower than the lowest point on the applicant's property. It is 0.317m below the top of the garage slab, 1.447m below the level of the floor, and 0.487m below the top of the seawall.
- 5.4.4 The expert then considered the likelihood (on a scale ranging from 'rare' to 'almost certain') of such an event happening during the design life of the applicants' buildings.
- Assuming a 1% AEP design event, as the threshold for a section 73 notice, and a 50-year life for the applicant's building, the likelihood of such an event being equalled or exceeded is ~39%... such an event would be towards the low end of the 'Possible' ranking...
- 5.4.5 With respect to the issue of how best to account for sea level rise over the design life of the building, the expert considered that based on government guidelines released in 2017¹⁶, 'sea level rise with the potential to affect the applicants' property over the next 50-years could range from about 0.25m up to about 0.50m'. However, the authority's submission referred to it having adopted a sea level rise of 0.5m over 50-years for a number of years, and data collected over the last 20-years from both Bridge Street and Sumner Head show an average increase in annual maximum high tide of 10mm/year.
- 5.4.6 The expert considered the 500mm estimated sea level rise favoured by the authority while 'not unreasonable' was in his opinion 'conservative' and 'potentially high'. Even if this conservative estimate was used, the resulting design water level for the

¹⁵ The measurement of depth of water in oceans, seas, lakes, and similar.

¹⁶ Ministry for the Environment. (2017). *Coastal hazards and climate change*. Wellington: Ministry for the Environment.

applicants' property would be RL 11.413, meaning that 'the largest waves would have the potential to exceed the height of the sea wall by 13mm'.

5.5 Depth and duration of inundation

- 5.5.1 From his observations about the potential sources and extent of future flooding on the applicants' land, the expert concluded that 'the risk of inundation is extremely low', and in the unlikely event that there was flooding 'it will be of a shallow depth and its velocity will be slow'. He also considered that inundation from high sea levels was 'extremely unlikely', and if it occurred, would be 'shallow as any water will flow out across the land once a wave overtops the sea wall'.
- 5.5.2 In addition, any inundation that did occur is 'likely to persist for only a very short time', due to the comprehensive surface water removal system that the applicants have installed. Any coastal inundation would only come from 'the largest of the waves and persist only for the duration of about an hour around high tide'.
- 5.5.3 Based on these observations, the expert concluded that the identified natural hazard of inundation 'has a low potential to affect the property, and no 'realistic' potential to affect the building'. In his opinion, the section 73 notice was not warranted.

5.6 The authority's response to the expert's report

- 5.6.1 The authority emailed a submission in response to the expert's report on 28 June 2019. The main points related to:

Pluvial inundation

- Uplift of the flood plain areas and less secondary flow paths (due to increased building) mean that maximum flood levels higher than RL 11.1m are realistic.
- 10 hours is a realistic critical duration for this flood plain, and taking into account a 16% increase in rainfall densities as a result of future climate change, a storm of the intensity experienced in March 2014 would have an ARI¹⁷ of 32 years (equivalent to a 0.32% AEP).

Coastal inundation

- While the peak water level during a storm tide would have a limited duration, there may be several peak tides during a storm.
- The authority accepts that it is reasonable to use water level data from the Sumner Head tide gauge for the applicants' property; however, there have been instances where estuary water levels have been higher than the Sumner water levels.
- The figures relied on by the expert to calculate a 1% AEP design water level of RL 10.913m for the applicants' property is based on 2010 data. There have been three events where levels at Sumner Head were higher than this in the past nine years. The authority's expert's report, on the other hand, is based on 2018 data and assesses the level as RL 11.153, some 240mm higher.
- The expert has not commented on using a deterministic method to assess the probability of inundation. Such a method would be useful to assess future cases.

¹⁷ Annual Recurrence Interval being the average number of years that it is predicted will pass before an event of a given magnitude occurs.

- The 0.5m estimated sea level rise used by the authority is based on data from the past 20 years and is not conservative.

5.7 The expert's technical memorandum

5.8 At my request the expert considered the points raised by the authority (above) and provided a response to those, in a technical memorandum dated 4 July 2019 that was sent to the parties on 16 July 2019. The main points were:

Pluvial inundation

- The October 2000 event provides useful information about how the area responded to a large rainfall event, which is more reliable than the results from modelling. The applicants' property did not flood during this event. While landscape and drainage patterns will have changed since the event, there will be both positive and negative changes.
- The March 2014 rainstorm was an extreme event and provided 'direct empirical evidence' for the applicants' property. The event generated 'significant, possibly unprecedented, flooding and inundation' and the fact that it did not flood the applicants' property is significant and indicates what is likely to happen in future events.
- Increased rainfall intensities do not necessarily equate with larger flood events, and it is not simply a matter of extrapolating from existing data to determine what impact increased rainfall as a result of climate change will have on inundation frequencies. The critical duration of rainfall events is also not determinative.

Coastal inundation

- It is extremely difficult to model the probability of high tides and peak surface water runoff coinciding. The 'relatively short duration' of both events reduces the likelihood of them coinciding; this likelihood is relatively low'.
- Waves splashing over a low seawall are not likely to present a significant risk of inundation.
- The applicants' property is located at the entrance to the estuary, and the wind set-up experienced at this location will be different from at the location of the two estuary tide gauges: Ferrymead and Bridge Street. Neither of these gauges give 'representative values' for the applicants' property.
- The more recent tide data from Sumner Head shows increases in water levels greater than RL10.913, but the level of increase represents a difference of less than 0.2m, which is within the ±2% confidence interval. Although the more recent data could be reanalysed, the expert expects that it would 'make no significant difference'.
- The authority's expert has used a different methodology than that used by the expert to calculate the 1% AEP sea water level. Different methods give different results, and have different advantages and disadvantages; the choice of which method to use is subjective and should be decided by statistical constraints, professional judgement and appetite for risk.

- The authority's suggested approach of using a probability of 39.5% to assess the level of risk is an 'excellent first step', but should not be rigidly applied and must allow for 'site-specific factors, uncertainty, and the magnitude of potential effects'.

6. The draft determination and submissions received

6.1 General

- 6.1.1 A draft determination was issued to the parties for comment on 2 September 2019.
- 6.1.2 Both parties made submissions on the draft determination, which were referred to the expert for comment. In response, the expert provided a second technical memorandum dated 3 October 2019 which was sent to the parties on 7 October 2019. Both parties then made further submissions on this technical memorandum.
- 6.1.3 All of these submissions and the expert's second technical memorandum on the draft are summarised below. I have taken them into account in making my final determination.

6.2 The authority's submission on the draft

- 6.2.1 The authority did not accept the draft determination and made a submission on it dated 10 September 2019. The submission responded to specific aspects of the draft determination, as summarised below:

Seawalls on adjacent properties	<ul style="list-style-type: none"> There is no requirement or undertaking by the authority or the applicants' neighbours to 'implement and maintain a floodwall for communal protection'. A number of properties in the area have already constructed walls, which vary in height from 11.2m to 11.41m, while others have no wall or damaged walls. The wall on the immediate neighbour's property is damaged, and ground levels are RL 10.7m in parts. The applicants cannot rely on a continuous seawall of sufficient height being constructed along the coast. Their own design does not provide any protection along the flanks or road end of the site, and is 'not controlling these avenues for the entry of tidal water'.
Levels of inundation	<ul style="list-style-type: none"> Even shallow depths of floodwaters (below 400mm) can pose a risk to the safety of more vulnerable people.
Adequacy of the applicants' seawall	<ul style="list-style-type: none"> Based on probability theory, and using the Sumner Head tide gauge data, there is a 78% probability that the seawall's height of 11.4m RL will be exceeded in 50 years. Over the past few years all of the tide gauges have recorded high tide levels of over RL 11.0. Any of these recorded levels combined with a 500mm sea level rise would result in seawater overtopping the seawall.
Garage design	<ul style="list-style-type: none"> The garage may still be inundated in the absence of a section 73 notice, people may store things in it that will be damaged.
Recorded sea levels at the tide gauges	<ul style="list-style-type: none"> The appropriate gauge to use is Sumner Head, which has a 1% AEP level of RL 11.153. The gauge is close to the estuary mouth, and at high tide experiences a free flow of water from the open sea. The Ferrymead levels have a 'wind set-down effect' in them, which is why they are lower. The applicants' property is not subject to such effects, as it is sheltered by the hills. There is no allowance for local wave effects in the RLs being applied. Most of the time the high tide levels at the various tide gauges are within 30mm of each other.
Predicted sea level rises	<ul style="list-style-type: none"> The 500mm estimated sea level rise over the next 50 years is 'quite possibly an under-estimate', when the upward trend in high tide data taken from the Sumner Head gauge is taken into account.

Over-topping of the seawall	<ul style="list-style-type: none"> The water level estimates are taken in 'calm surface conditions'. Wave crests are above that level, 'so at least half of any local wave height would be above RL11.413'; not the occasional overtopping proposed by the expert. 'With an on-shore wind generating waves, the flow would be more or less continuous and amplified at each wave crest.' At RL 11.413 the flow over the applicants' seawall 'would create a flow of about 40 litres/sec across the wall and take about 1 hour and 40 minutes to fill their site to a depth of 400mm.' 'Today's correct figure' for a 1% AEP tidal level at the Sumner Head gauge is RL 11.153, which when added to a predicted sea level rise of 500mm means the applicants' seawall will be over-topped by 253mm. In addition, the lack of a continuous seawall means that tidal water would also enter from the property's flanks or rear, and this would happen much more often than once every 100 years.
Pluvial flooding	<ul style="list-style-type: none"> Low atmospheric pressure generates high tides and accompanies many rainfall events, so the coincidence of the two events is 'reasonably likely'.
Statistical methods adopted	<ul style="list-style-type: none"> The statistical method used to calculate 1% AEP tide levels is 'not really the issue'. It is more important that up-to-date data is used.
The data used	<ul style="list-style-type: none"> The expert has not used up-to-date data, and has not recognised the 'authoritative and corroborated' tide data being used by the authority. When up-to-date tide levels are used, even smaller events with a greater frequency than 1% AEP may cause inundation. If the up-to-date data is used, the applicants will require 'a wall of at least 11.65m around the entire property to prevent flows from any direction coming on to it' and water would still be splashing in from waves.

6.3 The applicants' submission on the draft

6.3.1 The applicants accepted the draft determination and made a submission dated 13 September 2019. The submission responded both to the draft determination and the authority's submission on the draft, as summarised below.

Data used	<ul style="list-style-type: none"> The determination should be based on the data available to the authority when the Building Consent was issued. The tide level data from Sumner Head includes 'open-water waves', but there is a dampening effect in the estuary.
Predicted sea level rises	<ul style="list-style-type: none"> The data originally relied on by the authority included an allowance of 400mm for sea level rise, so the authority's 500mm allowance is conservative. These levels also allowed 400mm for 'wave set-up effects' despite these already being accounted for in the water level records, 'adding further conservatism to sea level projections'. The set-up effect would not in any case apply at the applicants' property, because the site is protected from storm winds coming from the south and southwest.
Seawalls on adjacent properties	<ul style="list-style-type: none"> The neighbouring properties on both sides of the applicants' property had seawalls at the time of the building consent, although they had been damaged by earthquakes. The applicants' seawall is connected to the seawall on the neighbouring property to the north using 'an engineer designed jointing system agreed between neighbours and their consultants'. The owner of the property to the south has since demolished the wall, and is in the process of rebuilding it. The new wall will link with the applicants' wall to form 'a continuous barrier to the sea'.

Over-topping of the seawall	<ul style="list-style-type: none"> The applicants' expert advises that there are 'no wave recordings inside the estuary on which to base run up and overtopping calculations'; and that in general any waves that reached the applicants' site would be limited by shallow estuary water depths and 'short fetch length, while over-topping would be limited by 'water depths at the toe of the wall and the duration of high water levels'. In the event that there is over-topping to the extent predicted by the authority in 50 years' time, the non-return valves will enable it to drain and 'the wall can be heightened prior to the projected 50 year level being reached'.
Pluvial flooding	<ul style="list-style-type: none"> Pluvial flooding coincided with high tides during the March 2014 storm, which was a 0.4% AEP event, but the applicants' site did not flood.
1% AEP levels	<ul style="list-style-type: none"> The 1% AEP tide levels includes 'all components of astronomical tide and storm surge', including 'an allowance for storm waves'.

6.4 The expert's second technical memorandum

6.4.1 The expert provided a second technical memorandum dated 3 October 2019. The memorandum commented on the key points raised in the parties' submissions on the draft determination.

6.4.2 The expert stated that in his opinion:

- the key issue appeared to be the level of risk that could be considered acceptable, with the parties taking differing approaches to risk, and the question to be answered being 'when does the risk get to a level that a Section 73 notice is appropriate'
- no additional information had been provided by either party to alter the analysis or conclusions in his report of 11 June 2019.

6.4.3 The main points from the expert's second technical memorandum were:

Design water levels

- A principal area of dispute is the design water levels adjacent to the applicants' property and how these interact with the seawall, taking into account predicted sea level rises.
- Irrespective of what design water levels are adopted, the uncertainty is 'generally in the order of a few centimetres' and there will always be some level of residual risk that must be managed. This is managed for the applicants' property through the elevation of the house above the ground, the multiple non-return valves in the seawall, and the ability to increase the height of the seawall if required.
- The 1% AEP level calculated by the expert includes an allowance for storm waves.
- Information provided by the Ministry for the Environment in 2017 (see paragraph 5.4.5) indicates sea level rises with the potential to affect the applicants' property over the next 50 years could range from 0.25m to 0.50m. At the time the consents were issued, a 0.50m sea level rise over 50 years would have been considered conservative, and is still conservative in the expert's opinion.
- The design water levels used by the applicant during the consenting process were appropriate and also would have been considered conservative at the time.

- The authority has provided more recent data which it considers shows the risk to the applicants' property is 'greater than initially assessed'. There are issues with using this data, including the inappropriateness of using short-term data for statistical analysis, the fact that it ignores longer-term trends, and the lack of analysis around the environmental processes affecting the data. The data was also not the data that was current when the consent was issued.
- The expert stands by the conclusion in his initial report that: 'Any flooding of the applicants' property, even under the most extreme conditions, will be infrequent, of short duration, of shallow depth, and of low velocity.'

Continuity and height of seawall

- There is no immediate risk of the seawall being overtapped or outflanked, but the need for a seawall will increase over time.
- The height of the seawall and the level of protection it provides is 'intimately connected with predictions of sea level rise'. Irrespective of what predicted water levels are used, the wall will only be overtapped by the largest waves, and only 'after approximately 50 years assuming a very conservative rate of sea level rise'.
- Discussions between adjacent property owners to create a continuous seawall 'appear to occur organically'.
- The seawall provides 'direct protection against high sea levels and waves', but even if water does overtop or outflank the wall, this will only be 'spread out at a shallow depth over the land behind the wall' and the floor level of the house will be well above this.
- In the expert's opinion, the level of risk of the seawall being overtapped is 'extremely low' and this risk can be mitigated in the future, if required, by raising the height of the seawall.
- The authority's analysis, which shows that inundation over the top of the seawall 'is not minor and could represent a considerable hazard', is 'wrong and extremely misleading'. The analysis assumes that 'the wall is overtapped continuously rather than intermittently by only the larger waves', but in fact the actual amount of water overtopping the wall 'would be a function of the nature of the wave train', and will only be 'a few percent of the volume' calculated by the authority.

Period of data

- The authority is now relying on data that was not available when the building consent was granted, but the data to be used in deciding whether a section 73 notice is appropriate should be that which was available when the consent was issued.
- There is a 'quantum shift' in some of the authority's new data from the 'expected or long-term pattern', and there is uncertainty as to its accuracy, reliability and whether it represents 'short-term variability or longer-term trends'.
- 'It is not good practice to use short data records when predicting longer-term trends'.

- The average sea-level rise of 9.4mm/year over the past 20 years, cited by the authority, is inconsistent with ‘other local, national and global sea level records’, but would still only result in a total sea level rise over 50 years of 0.47m. ‘Therefore, an assumed sea level rise over the next 50-years of 0.5m would seem reasonable but conservative’.

Effects of inundation

- The authority’s submissions ‘relating the depth of inundation to its effect’ is not relevant to the applicants’ property, as the ‘frequency, extent and depth of potential inundation to the applicants’ property are extremely low’.

Coincidence of extreme events

- While the coincidence of high rainfall (pluvial) and high sea level events would elevate overall water levels and risk of flooding, they would also reduce the ‘frequency of such an event’. The inundation in March 2014 coincided high sea levels with a 0.4% AEP rainfall event. The combined probability of the two events was therefore likely to be less than 0.1% (1 in 1000 years) yet the applicants’ property did not flood. Therefore, the property ‘would certainly not be adversely affected during a 1% AEP event over the next 50 years’. In the expert’s opinion, ‘greater confidence’ should be placed on the property’s performance during these ‘actual and recorded events’ than on the results of models.

6.5 The authority’s response

6.5.1 The authority made a further submission received on 15 October 2019. The submission responded to the expert’s second technical memorandum, as summarised below:

Design water levels	<ul style="list-style-type: none"> Waves are largely irrelevant in the estuary environment, and tidal flooding often occurs in calm conditions. The measured tide level data is effectively the mid-height of the wave, not the crest, and in calm conditions would represent the actual water level without any waves. At a mid-height of 25cm above the top of the wall, the flow would be 3.4 cubic metres per second and this would occur on all the properties along the coastline, some of which have no sea wall or lower sea walls than the applicants’. Accordingly, the water would not spread onto these neighbouring properties, as they would be similarly inundated.
Available data	<ul style="list-style-type: none"> The authority accepts that the data to be used is that which was publicly available at the time the consent was issued. The authority’s expert has used data in excess of 20 years (and up to 45 years) in his analysis. The average annual increase of 9.4mm is consistent with ‘widely publicised scientific information which suggests a sea level rise of 1m in 100 years - i.e. 10mm per year’. The new data is based on the same method as the ‘previous design tide levels the decision was based on’ and is more accurate.
Risk of tidal inundation	<ul style="list-style-type: none"> The expert does not provide evidence for his belief that inundation will not be serious. The authority maintains that flows of about $3.4\text{m}^3/\text{s}$ over the applicants’ sea wall can be expected. The seawall will initially be outflanked, then overtapped, in large events, and will cause complete inundation of the site and garage.

Continuity of the seawall	<ul style="list-style-type: none"> • 'The neighbours cannot be relied on to co-operate and resource the design, construction and maintenance to ensure that tidal flooding does not occur at any point of any residence along the sea front now and in the future.' • 'The Building Act has no provision to presume that future protection will be provided by others' and 'the current seawalls do not provide protection to the sides of the property'. • A section 73 notice would provide notice of the hazard on the title and could be removed under section 74 if a continuous seawall provides protection from this hazard in the future. • 'It must be clear to the current and any future owners that the responsibilities for tidal flood protection on this site rests squarely with the owner and not the [authority].' The building consent was issued on this basis.
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6.5.2 The authority provided two photos of tidal flooding on the estuary in calm conditions with its submission.

6.6 The applicants' response

6.6.1 The applicants made a further submission dated 23 October 2019. The main points were:

- the photos provided by the authority are not relevant, as they are not located near to the applicants' property
- it is not disputed by the authority that during the most 'extreme event recorded in the area' (the March 2014 0.4% AEP event), when high rain fall and tides coincided, the applicants' property did not flood, nor did the road in front of it
- the applicants do not 'expect' the authority to provide flood protection along the sea front, but note that although there is no requirement for seawalls to be built, many property owners have already done so.

7. The legislation

7.1 Sections 71 to 74 of the Act

7.1.1 The provisions relating to the construction of a building on land that is subject to natural hazards, are found in sections 71 to 74 of the Act (see Appendix A.1).

7.1.2 Under section 71(1):

- (1) A building consent authority must refuse to grant a building consent for construction of a building, or major alterations to a building, if –
 - a) the land on which the building work is to be carried out is subject or is likely to be subject to 1 or more natural hazards; or
 - b) the building work is likely to accelerate, worsen, or result in a natural hazard on that land or any other property.

7.1.3 The circumstances in which building consent authorities will be required to consider the application of the natural hazard provisions will vary, and authorities should turn their minds to both subsections 71(1)(a) and (b), although in some cases only one of these will be relevant. Authorities may also need to consider more than one natural hazard.

- 7.1.4 Section 71(2) provides that if certain conditions are satisfied, section 71(1) does not apply:
- (2) Subsection (1) does not apply if the building consent authority is satisfied that adequate provision has been or will be made to—
- (a) protect the land, building work, or other property referred to in that subsection from the natural hazard or hazards; or
- (b) restore any damage to that land or other property as a result of the building work.
- 7.1.5 Section 71(3) details the types of natural hazards that section 71 to 74 apply to, and these include inundation.
- 7.1.6 Section 72 sets out the circumstances in which a building consent authority must still grant a building consent for building work, even though the land on which the work is to occur is subject to one or more natural hazards.
- 7.1.7 Section 73 sets out the conditions that building consent authorities must include in a building consent when it is issued under section 72, including notification of the consent to the Registrar General of Land.
- 7.1.8 Section 74 describes the steps that must be taken after notification, including in circumstances where the building consent authority determines that a notification is no longer required.
- 7.1.9 An important purpose of the natural hazard provisions within sections 71 to 74 is to ensure consideration is given to how building work affects natural hazards and impacts on the land or other property. The provisions do not prevent building work being undertaken on land that is subject to natural hazards, unless the building work will accelerate, worsen or result in a natural hazard on the land on which the building work is to be carried out or to any other property.
- 7.1.10 Where building work is undertaken on land that is subject to a natural hazard and the building work will not accelerate or worsen the natural hazard, the purposes of the provisions are to:
- notify of the existence of natural hazards by placing a notice on the title
 - ensure the building work is protected from the natural hazard
 - confirm that the building consent authority has considered the natural hazard when granting the building consent
 - give an authority certain protections from liability, under section 392(3) of the Act, relating to its decision to grant a building consent notwithstanding the natural hazard.
- 7.1.11 To put it another way, the natural hazard provisions exist so that the risk to land and other property can be recognised, the effect of the building work considered, and steps taken to mitigate those risks and effects. Where the risks and effects cannot be sufficiently mitigated, but the land is still subject to a natural hazard, then the provisions recognise that it may nevertheless be acceptable to build on the land and require notification of the risk on the title to the land, and provide regulatory authorities with protection from liability (on the basis that the owner is knowingly building on land affected by the natural hazard). Placing a notice on the title ensures that future purchasers and other interested parties are aware that the land is subject to a natural hazard.

7.2 The natural hazards decision tree

- 7.2.1 In the course of preparing several past determinations, a natural hazards decision tree has been developed to clarify the steps involved in applying the natural hazard provisions of sections 71 to 73.
- 7.2.2 A copy of this tree is appended to this determination (see Appendix B) with appropriate annotations relevant to this particular case.
- 7.2.3 It is important to note that the natural hazards decision tree is a simplified tool and there will be a number of factors that need to be considered at each step of the process in any given case.

8. Discussion

8.1 General

- 8.1.1 The matter for determination is whether the authority was correct to issue a building consent for the building work on the applicants' land with a section 73 notification condition attached. The authority considers that the condition and notification are necessary because the applicants' property is subject to a natural hazard, namely inundation. The applicants consider it is not, and that they have taken extensive steps to protect both the land and buildings from inundation.
- 8.1.2 Following the process prescribed in the Act, and summarised in the natural hazards decision tree, the first question that needs to be considered is whether the building work would comply with the Building Code if there was no natural hazard present. In the current case it would. The authority has accepted that the building work complies with the Building Code and has issued a building consent for it. In issuing the consent, the authority has also accepted that the building is adequately protected from the effects of any inundation hazard (if there is one).
- 8.1.3 The next two questions are also satisfied as:
- the building work involves construction of a new building – section 71(1)
 - the building work will not accelerate, worsen or result in a natural hazard on the applicants' land or another property – sections 71(1)(b) and 71(3).
- 8.1.4 This brings us to the crux of the matter in the current dispute, namely whether at the time building consent for the house was granted the land on which the building work will be carried out was subject or was likely to be subject to a natural hazard – section 71(1)(a). Relevant to this question is the fact that at the time the building consent for the house was granted the seawall had been consented but construction of the seawall was not complete. Accordingly, I must also consider whether, at the time building consent for the house was granted, adequate provision was going to be made, by way of the completed construction of the seawall, to protect the land and building work.
- 8.1.5 There are several elements that need to be considered in relation to this question including what constitutes a natural hazard, whether the land is likely to be subject to one pending completion of the seawall, and whether it will affect the land on which the building work is to be carried out.

8.2 Is there a natural hazard?

- 8.2.1 The natural hazard in question here is inundation and there are two potential sources of it: inundation from rainwater during a storm event (pluvial inundation), and

inundation from seawater during extreme high tides, storms and sea level rise (coastal inundation). I accept the expert's assessment that there is no risk of fluvial inundation as there are no streams or watercourses nearby.

- 8.2.2 In *Logan v Auckland City Council*¹⁸, the Court of Appeal noted that some judgment is required in determining whether land will be subject to a natural hazard, and that such judgment involves 'a sensible assessment involving considerations of fact and degree'. The provisions in the Act do not require the elimination of all hazards.
- 8.2.3 Following this, the approach established in previous determinations¹⁹ has been that section 71 requires assessments of both:
- the likelihood of a given natural hazard occurring
 - whether the effect of a natural hazard will be more than minimal or trivial.
- 8.2.4 With respect to likelihood, section 71(3)(a) to (e) defines a natural hazard by the event occurring (in this case inundation) but does not give an indication of the extent of that event. Previous determinations²⁰ have taken the approach that a 100-year flood event (or 1% AEP) is an appropriate measure in relation to inundation and the "likelihood" test in section 71(1) and I maintain that view. In other words, land will be subject to inundation if it is likely that during a 1% AEP flood event the land will be inundated.
- 8.2.5 In regards to whether inundation is more than minimal or trivial, this was considered in Determination 2013/047²¹. That determination concerned a site on which a garage was being constructed that was likely to be subject to inundation in a 1% AEP, and where inundation would occur over a large area of the site. Paragraph 6.3.1 of the determination concluded that the inundation was not a natural hazard for the purpose of section 71 because:
- it would be of temporary and minimal effect, and
 - it had no potential to affect the land, the proposed building work or other property in such a way as to require protection, and
 - it did not have the potential to cause damage that would need to be restored.
- 8.2.6 In the current case, a large proportion of the parties' submissions have focussed on whether the applicants' property is likely to be subject to inundation during a 1% AEP flooding event, whether that be through pluvial flooding or coastal flooding, or a combination of the two.

Pluvial inundation

- 8.2.7 With respect to pluvial flooding, or flooding from rainfall, the expert was of the opinion that the applicants' property was unlikely to be subject to inundation during a 1% AEP rainfall event. The expert based this opinion on the data from two major rainfall events in the area in the past 10 years. In the first event (October 2010), the applicants' property was not subject to flooding at all. In the second event (March 2014) only the lower (estuary) end of the applicants' property was flooded, and the flood waters were slow moving and shallow. The expert noted that this event was

¹⁸ *Logan v Auckland City Council* (2000) 4 NZ ConvC 193, 184 (CA)

¹⁹ For example, Determination 2013/081 Regarding the issue of a building consent subject to a section 73 notice for a house on land subject to inundation (23 December 2013), and Determination 2017/048 Regarding the decision to grant a building consent subject to notification under section 73 for building work on land subject to a natural hazard (30 June 2017)

²⁰ See for example Determination 2008/082 Building consent for a storage shed on land subject to inundation (5 September 2008)

²¹ Determination 2013/047 Regarding the refusal to grant building consent without a section 73 notice for a garage on land subject to inundation (20 August 2013)

0.4% AEP and so would have been more extreme than the 1% AEP incidence that forms the basis for inundation. The expert considered that these events provided useful data as to how the applicants' property could be expected to perform in future events, and provided a better indication than could be gained through modelling.

- 8.2.8 I concur with the expert's reasoning. The past flood events show that the applicants' property is unlikely to be inundated as a result of pluvial flooding in an 1% AEP event, and that even if it was, the topography of the land in relation to the surrounding land and road mean that any inundation is likely to be slow moving and shallow. In addition, the applicants have raised the site levels of their land as part of the building work, further reducing the likelihood of inundation. The installation of a comprehensive surface water system, also as part of the building work, means that any rainwater that does make it onto the land is unlikely to pond, but will move slowly over the site and into the estuary through the non-return valves in the seawall.
- 8.2.9 I consider that the land on which the building work will be carried out is not likely to be subject to a natural hazard in respect of pluvial inundation.

Coastal inundation

- 8.2.10 With regard to the test under section 71(1)(a), it would seem there is no dispute that the land on which the building work to construct the house would have been subject or likely to be subject to coastal inundation prior to construction of the seawall. Accordingly, in considering the grant of building consent to construct the house, with reference to section 71(2)(a) the question then becomes whether or not adequate provision had been or would be made to protect the land and building work from that natural hazard.
- 8.2.11 The issue with respect to coastal inundation is complex, as in addition to the existing data about extreme tide levels and the effects of storms, there is the need to take into account what impact rising sea levels as a result of climate change are likely to have.
- 8.2.12 The parties have agreed to use the data from the Sumner Head tide gauge as the basis from which to estimate extreme tide levels at the applicants' property. They have also both adopted 500mm as a measure for the likely rise in sea levels over the 50 year minimum design life of the applicants' buildings, although the expert considers this measure to be conservative. The authority has acknowledged that it is the data available at the time that the building consent was issued that should be used.
- 8.2.13 Given this agreement I have not considered whether the determination can take account of information wasn't available to the authority at the time it granted the building consent, but I note that this matter has been considered in Determination 2019/006²² which discussed the circumstances where an issued building consent might be modified to take account of new information regarding a natural hazard.
- 8.2.14 The parties disagree, however, over which statistical method to use to extrapolate the data into 1% AEP levels over the 50-year design life of the building. The authority favours a simpler, more conservative approach (based on an extreme value analysis method), which gives a 1% AEP for the Sumner Head tide gauge (and hence the applicants' property) of RL 11.153m. The expert has used a more complex analysis

²² Determination 2019/006 Regarding the removal of an insanitary building notice and lack of notification of a natural hazard for a relocated building (29 March 2019)

(based on an empirical simulation technique) that provides a lower 1% AEP level of RL 10.913m – i.e. a reduction of some 240mm in the depth of the inundation.

- 8.2.15 In his technical memoranda, the expert has raised the issue of risk, in particular the residual risk that inundation will occur and affect a property and structures, even after design water levels have been set and met. This concept of risk is important to the natural hazard provisions in the Act. As I have already stated, these provisions do not seek to remove or address all risk. There will always be residual risk, and I agree with the expert's opinion that setting or calculating levels conservatively in order to minimise or eradicate this risk is not always the best approach.
- 8.2.16 Previous determinations have set the level at which inundation will meet the threshold for a natural hazard as 1% AEP. They have not, however, prescribed the method that should be used to calculate this level in particular cases. In choosing a method, the aim is not to calculate the level as conservatively as possible; rather it is to estimate the level accurately and realistically, given the available data. This is consistent with the approach in *Logan*, which calls for judgments about natural hazards to involve 'a sensible assessment involving considerations of fact and degree'.
- 8.2.17 In the current case, I accept that the method favoured by the expert reflects a variety of factors that will give a realistic estimate of the current 1% AEP extreme sea water levels at the applicants' property. When this level is combined with the 500mm allowance for sea level rise over the next 50 years, this gives a 1% AEP extreme sea level of RL 11.413m.
- 8.2.18 This means that in an extreme high tide, with a 1% AEP, the sea level in the estuary will exceed the top of the applicants' seawall by 13mm (the top of the seawall is RL 11.40m). Both the Ministry's and the applicants' experts are clear that these maximum tide levels include an allowance for storm waves. It will be the highest of these waves that are splashing over the sea wall and onto the applicants' land. The risk of this happening will be lower within the first period of the applicants' buildings' 50-year design life, but will increase steadily as time passes and base sea levels rise.
- 8.2.19 However, the mere fact that an inundation incident is likely to occur is not enough for that inundation to constitute a natural hazard for the purposes of the Act. Previous determinations have established that I must also look at the extent and duration of any inundation.
- 8.2.20 In the current case, any inundation from seawater will occur as a result of large estuary waves splashing over the wall at peak high tide. These waves will not be continuous, and I accept the expert's opinion that this will only deposit a limited amount of water onto the applicants' land. This water will have to remain until the tide retreats, which should be a relatively short period of one or two hours. The main area of the applicants' land affected will be that immediately adjacent to the sea wall, where the water could be expected to pond. This will be under the deck, and in the space between the house and the sea wall (a distance of 3.9m). If the ponding was large, it may extend under the front of the house, but this eventuality is unlikely. It will, in any event, be nowhere near the floor of the house which is raised 1.26m above the ground at this point.
- 8.2.21 Given all of these factors, I consider that the risk of coastal inundation of the applicants' land can be considered minimal or trivial. In essence, during a once in every 100-year extreme tide event, there may be some inundation caused by the

highest waves breaking over the top of the seawall. Given the nature of the surface water drainage works proposed by the applicant, I consider such inundation will last for a very short period, and is likely to be shallow and contained at the estuary end of the property. This is unlikely to occur more than once during the building's 50-year design life.

- 8.2.22 I acknowledge that the authority holds a contrary opinion, and considers that the flow of water over the top of the wall and onto the land may be significant and continuous. However, I consider that the authority is taking a very conservative approach to risk in this case. When this conservatism is factored into the data and its analysis at every step, the outcome is a worst-case scenario, which when viewed statistically is highly unlikely to eventuate.
- 8.2.23 As discussed above, the impacts of climate change and rising sea levels are not something that can be predicted with absolute accuracy, and hence it will never be possible to eliminate all risk. Nor is it contingent on property owners to guard against all risk, or open to authorities to compel them to do so, through overly conservative design requirements or other means. Instead a sensible assessment of risk is required. Yet, regardless of how scrupulously any assessment of risk is made, the fact remains that with regard to rising sea levels the risk may turn out to be either more, or less, than has been calculated.
- 8.2.24 In this situation, it is appropriate to take into account the fact that the applicants' property has significant mitigation measures in place to deal with flooding, even though the risk of that occurring is currently minimal. In this respect, in terms of section 71(2)(a) I consider the applicants' have taken adequate measures to protect their land.
- 8.2.25 The applicants' seawall is able to be made higher, should this be required. I also consider some allowance can be made for the natural desire of property owners to protect their assets, and that, should sea level rises within the next 50 years be far higher than anyone has yet predicted, it is unlikely that the applicants or any future owners will sit by and do nothing about it. However, it is important to be clear that such a scenario is an extreme one, and not something that a future owner needs to be alerted to by placing a section 73 notice on the title.
- 8.2.26 The authority has also raised concerns about the applicants' seawall being outflanked by tidal flooding on the neighbour's property, where the seawall is currently being replaced. I accept the applicants' advice that they are liaising with their neighbour about the construction of a new wall to the south, and the seawall is linked to a new engineered seawall to the north. I note that there is no immediate threat of the neighbour's land flooding during a high tide, as the existing ground levels of the property and the remnants of the existing seawall provide some protection. The possibility of the neighbour's property being inundated will only arise in later years, as sea levels rise, and, as with the applicants' property, I consider it unlikely that the owner of that property will do nothing to protect his or her property against that eventuality. Overall, I do not consider the risk of tidal flooding via a neighbouring property can be taken into account at this stage.
- 8.2.27 I note the neighbouring properties may remove and not replace seawalls. However, the removal of the seawalls is of itself building work which is required to satisfy the Building Code with respect to the protection of "other [i.e., the applicants'] property" under Clause E1 Surface water.

- 8.2.28 Judging from the few photos provided in the submissions from the applicants and by the expert, the neighbouring land is at the same level as the applicants' land, if not marginally higher. In the event that water might flow from the neighbouring land onto this property, it is unlikely to be at any greater depth and duration than that contemplated by the expert; the mitigation measures will remain effective and will ensure any water arriving on the applicants' land will drain to the estuary.
- 8.2.29 There are too many uncertainties associated with it that are beyond the applicants' ability to control. In my opinion, it would be excessively onerous to require the applicants to mitigate against such a risk at this stage, when there is no evidence that it will ever eventuate.

Coincidence of events

- 8.2.30 The authority has raised the possibility that should such coastal inundation coincide with an extreme rain fall event, there could be more extensive inundation on the applicants' property. The expert considers the probability of such a coincidence 'extremely low' and hard to predict. I accept that this is the case. The purpose of the natural hazard provisions is to guard against hazards that are likely to occur, not those caused by an unfortunate confluence of events.
- 8.2.31 All of the parties have referred to the March 2014 rainfall event, which had a 0.4% AEP and coincided with a high tide. No inundation was experienced on the applicants' property or on the land immediately adjacent to it during this event. I agree with the point made by both the expert and the applicants' that this actual event provides a better indication than any theoretical modelling of what the impact on the applicants' property is likely to be should the two events coincide in the future. Given the very low probability of an event of this magnitude reoccurring within the next 50 years, the even lower probability of it coinciding with a very high tide, and the evidence that the applicants' property is, in any event, unlikely to flood, I do not consider this is a risk that needs to be considered further.
- 8.2.32 I also note that even if this situation did arise, although it may give rise to more extensive flooding than might occur solely from an extreme tide, this too would be short-lived, as once the tide receded, any water trapped on the land, from whichever source, would be drained through the non-return valves in the wall. Based on past rainfall data, any such flooding is unlikely to affect access to the house.

8.3 Conclusion

- 8.3.1 I consider that at the time the authority granted building consent for construction of the house:
- the land on which the building work was to be carried out to construct the house was not likely to be subject to the natural hazard in respect of pluvial inundation
 - adequate provision was going to be made by way of construction of the seawall to protect the land and building work from the natural hazard coastal inundation;
- 8.3.2 I consider that any future inundation of the applicants' property, either from rain or sea water, is likely to be minor and short lived, to the extent that it would not constitute a natural hazard for the purposes of section 71(1)(a) of the Act.

- 8.3.3 Based on these conclusions, there was no need for a section 73 notice to be placed against the title alerting people to the presence of a hazard.
- 8.3.4 The authority should now:
- issue an amended building consent without the condition relating to building on land that is subject to natural hazards in it
 - apply to the Registrar-General under section 74 of the Act to have the section 73 notification removed from the certificate of title for the applicants' property if that notification has already been made.

9. The decision

- 9.1 In accordance with section 188 of the Building Act 2004, I hereby determine that the authority incorrectly granted the building consent subject to a section 73 notice. Accordingly, I modify the authority's decision to grant the building consent as described in paragraph 8.3.4 of this determination.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 20 December 2019.

Katie Gordon
Manager Determinations

Appendix A

A.1 The relevant sections of the Building Act 2004 include:

71 Building on land subject to natural hazards

- (1) A building consent authority must refuse to grant a building consent for construction of a building, or major alterations to a building, if—
 - (a) the land on which the building work is to be carried out is subject or is likely to be subject to 1 or more natural hazards; or
 - (b) the building work is likely to accelerate, worsen, or result in a natural hazard on that land or any other property.
- (2) Subsection (1) does not apply if the building consent authority is satisfied that adequate provision has been or will be made to—
 - (a) protect the land, building work, or other property referred to in that subsection from the natural hazard or hazards; or
 - (b) restore any damage to that land or other property as a result of the building work.
- (3) In this section and sections 72 to 74, natural hazard means any of the following:
 - (a)...
 - (d) inundation (including flooding, overland flow, storm surge, tidal effects, and ponding):...

72 Building consent for building on land subject to natural hazards must be granted in certain cases

Despite section 71, a building consent authority that is a territorial authority must grant a building consent if the building consent authority considers that—

- (a) the building work to which an application for a building consent relates will not accelerate, worsen, or result in a natural hazard on the land on which the building work is to be carried out or any other property; and
- (b) the land is subject or is likely to be subject to 1 or more natural hazards; and
- (c) it is reasonable to grant a waiver or modification of the building code in respect of the natural hazard concerned.

73 Conditions on building consents granted under section 72

- (1) A building consent authority that is a territorial authority that grants a building consent under section 72 must include, as a condition of the consent, that the building consent authority will, on issuing the consent, notify the consent to,—
 - ...
 - (c) in any other case, the Registrar-General of Land.

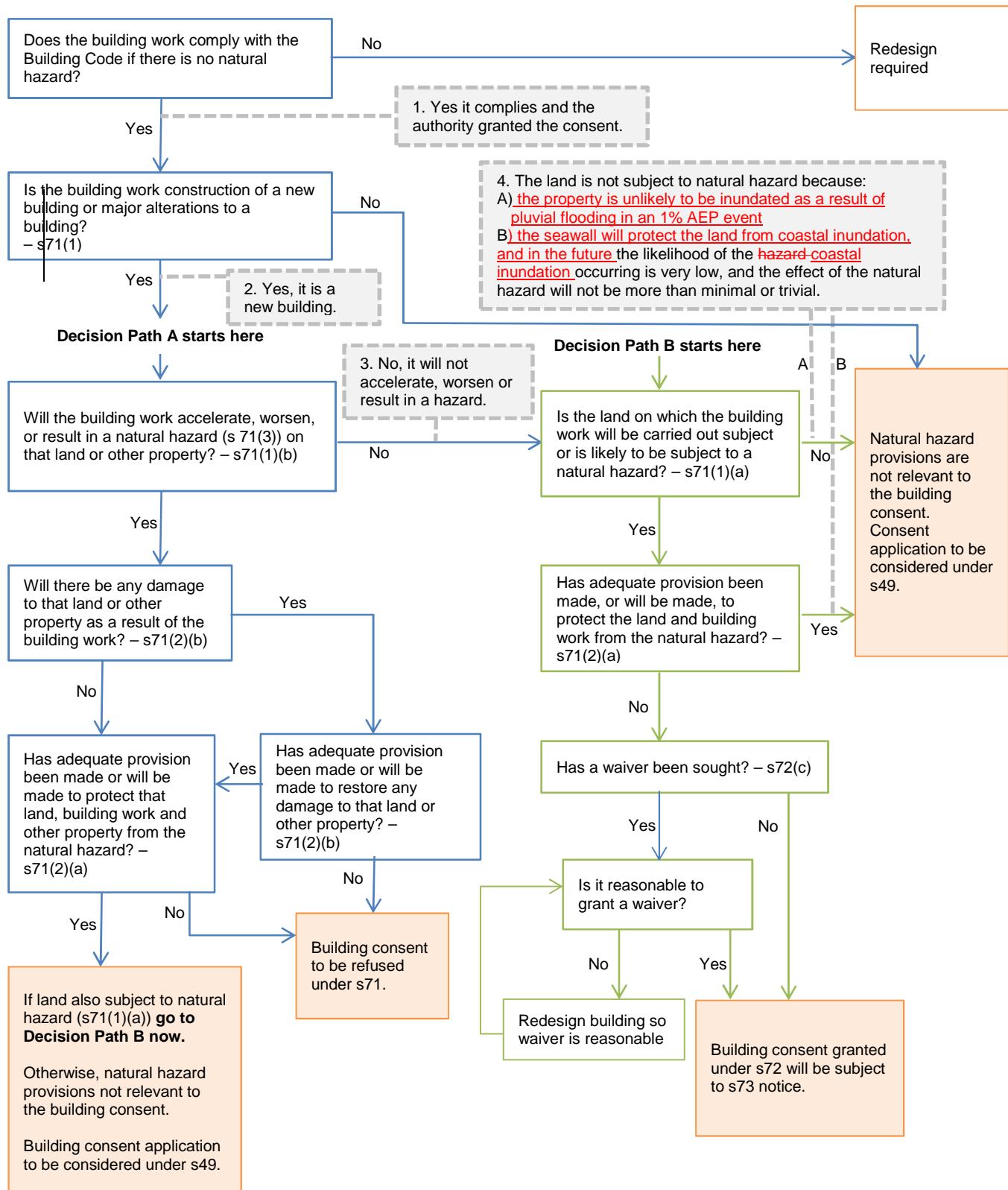
74 Steps after notification

- (1) On receiving a notification under section 73,—
 - (a) the Surveyor-General or the Registrar of the Maori Land Court, as the case may be, must enter in his or her records the particulars of the notification together with a copy of any project information memorandum that accompanied the notification;
 - (b) the Registrar-General of Land must record, as an entry on the certificate of title to the land on which the building work is carried out,—
 - (i) that a building consent has been granted under section 72; and

- (ii) particulars that identify the natural hazard concerned.
- (2) If an entry has been recorded on a duplicate of the certificate of title referred to in subsection (1)(b) under section 641A of the Local Government Act 1974 or section 36 of the former Act, the Registrar-General of Land does not need to record another entry on the duplicate.
- (3) Subsection (4) applies if a building consent authority determines that any of the following entries is no longer required:
- (a) an entry referred to in subsection (1)(b);
 - (b) an entry under section 641A of the Local Government Act 1974;
 - (c) an entry under section 36 of the former Act.
- (4) The building consent authority must notify the Surveyor-General, the Registrar of the Maori Land Court, or the Registrar-General of Land, as the case may be, who must amend his or her records or remove the entry from the certificate of title.

Appendix B: Natural Hazards Decision Tree²³

(with annotations specific to this determination)



²³ Note: this is a simplified tool developed to clarify the steps in applying the natural hazard provisions of sections 71 to 73 of the Act and there are a number of factors to consider at each step of the process.