Flood hazard evaluation for subdivisions in areas of coastal inundation hazard

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ABSTRACT

This paper discusses the outcomes of a recent resource consent hearing and environment court decision for a subdivision consent application for a proposed 66 lot subdivision on low lying land adjacent to the Kaipara Harbour in Auckland. The initial consent application was refused on grounds that the applicant had designed the subdivision to have all building platforms above the future coastal inundation 100 year ARI flood level, but the hazard arising from future coastal inundation on footpaths, roads and reserves had not been appropriately avoided, remedied or mitigated. The decision found that the potential adverse effects would be significant, unacceptable and more than minor. A subsequent appeal to the environment court resulted in the consent being granted subject to raising the road levels to avoid flooding to more than 500 mm depth of water. This was considered acceptable to mitigate the hazard for vehicles and pedestrians in the event of inundation from flooding from the harbour due to extreme tide and wind conditions. The paper discusses the hazard at the site due to coastal inundation, including allowance for future sea level rise. This discussion includes how flood hazard is generally addressed by engineers from consideration of the depth and velocity of floodwater. It also discusses other considerations such as the nature of potentially affected population, their likely expectations of protection against flooding and how their activities might interact with a flood event. It discusses the possible implications of the consent order on planning and engineering practice with respect to assessing acceptable coastal flood hazard for subdivisions.

KEYWORDS

Flooding, coastal inundation, flood hazards, subdivision

PRESENTER PROFILE

Nigel is a chartered professional engineer with wide experience in range of environmental and civil engineering projects. He is a certified RMA commissioner with experience in a number of significant infrastructure consent hearings and decisions. He also teaches assessment of water related effects of development at Auckland University and for NZ Planning Institute's CPD programme.

1 INTRODUCTION

Flat land close to harbours and rivers remains attractive for development, including for residential subdivisions. Many of these areas in the Auckland region are low lying with many having been subject to drainage works to make them available for farming or urban development. Auckland Council has previously commissioned modelling work to assess extreme levels of coastal inundation by storm tides and waves in the Auckland region. For assessment of coastal inundation hazard the previously modelled extreme levels of coastal inundation can be used together with a site specific assessment to determine the flood hazard for the site. The risk of coastal inundation hazard is increasing due to the need to take future sea level rise due to climate change into account. This paper describes the findings of the resource consent hearing and subsequent environment court appeal with respect to flood hazard for a proposed subdivision in the Auckland region. It describes an assessment of coastal inundation hazard for the subdivision based and makes a number of recommendations for the assessment of flood hazard for coastal subdivisions.

2 BACKGROUND

2.1 DESCRIPTION AND LOCATION OF SITE

The site is low lying land, 10.1ha in area, at Parakai near the Kaipara River and Kaipara Harbour, north west of Auckland City. The location of the site is on Fordyce Road at Parakai as shown in Figure 1.

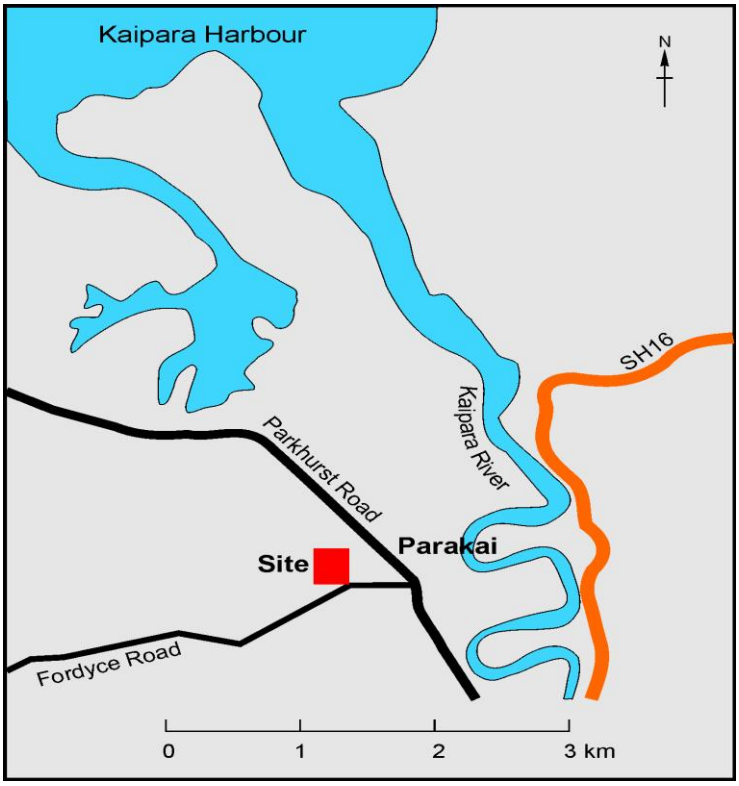

Figure 1 Location Map

The site has previously been used for grazing and adjoins an existing low-medium density residential subdivision at the existing western urban boundary of Parakai Township. The site has existing ground levels ranging from 2.3 to 2.8 metres above mean sea level. It has multiple stormwater overland flow paths through it and most of the site is located within a 100 year flood plain and is known to be a coastal inundation risk also. Coastal inundation can occur from the Kaipara Harbour to the north of the site and from the tidally affected reaches of the Kaipara River to the east of the site.

2.2 DESCRIPTION OF PROPOSED SUBDIVISON

The proposed subdivision comprises 65 residential lots with average site sizes of 600m^2. Two residential lots have been identified to be taken as a recreation reserve in accordance with the Council's reserves policy.

The layout of the proposed subdivision is shown in Figure 2.

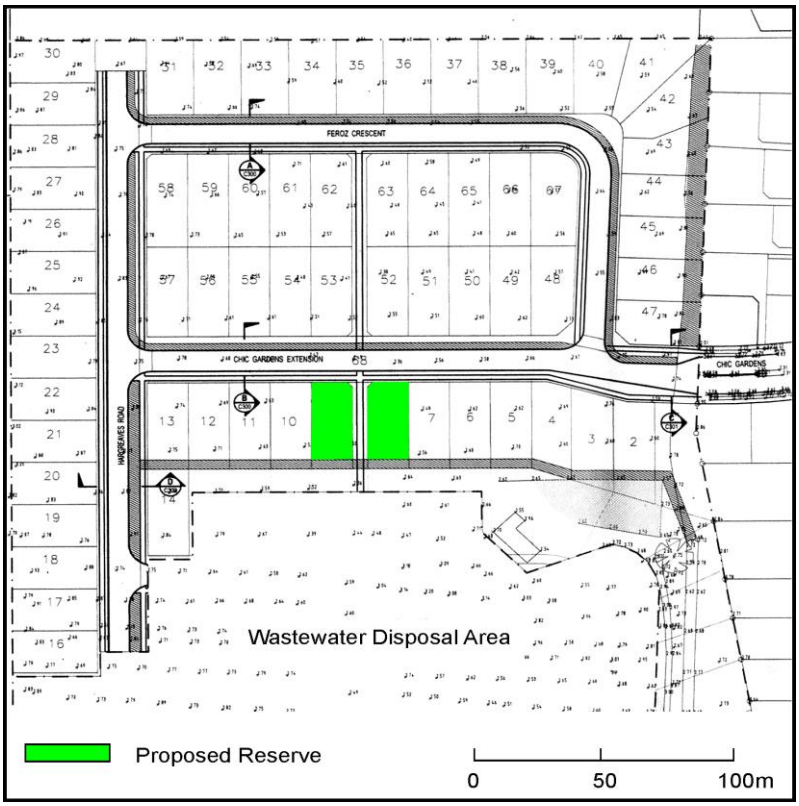

Figure 2 subdivision Layout

At the time of the resource consent hearing it was proposed to carry out 72,822m³ of earthworks over an area of 8.21ha including 43,240m³ of imported engineered fill to raise ground levels for future residential dwellings. The subdivision will be serviced by an on-site wastewater treatment and disposal system until such time as wastewater can be reticulated to Watercare's wastewater treatment plant at Helensville. However at the hearing, it was confirmed that most of the sites would in fact be fully reticulated leaving the wastewater reserve area eligible for further subdivision.

Stormwater run-off from the subdivision site will be reticulated through various measures such as water tanks, road swales and overland flow paths.

2.3 RESOURCE CONSENT APPLICATION AND DECISION

A hearing for the resource consent application for the subdivision was held in November 2014 and February 2015. The hearing panel comprised three independent commissioners appointed by Auckland Council. The authors of this paper were two of the commissioners.

The decision on the consent application was provided on 6 March 2015 (Consent Decision 56 Fordyce Road, 2015).

A summary of the application and the findings by the commissioners in relation to the coastal inundation hazard follow.

Under the Auckland Council District Plan - Rodney Section (Operative District Plan) the site is in the Future Urban zone. The minimum site area for subdivision in this zone is 4ha. Rule 13.8.1.9 states that subdivision not complying with development controls is a non-complying activity. As the proposed subdivision created 600m² lots the proposal required resource consent for a non-complying activity.

Consent was also required for a number of other activities including placing fill (earthworks), earthworks in a floodplain, protected tree removal, sediment and erosion control and wastewater disposal, which were discretionary or restricted discretionary activities. The overall consent status was non-complying.

2.3.1 ASSESSMENT OF RELEVANT PLANNING PROVISIONS

The consent decision noted the following operative planning documents are applicable in assessing the actual and potential effects resulting from natural hazards associated with coastal inundation, in particular, effects on public safety and access, and setting minimum floor levels for new houses:

1. New Zealand Coastal Policy Statement (2010) – (NZCPS)
2. Auckland Council Regional Policy Statement (1999) – (Regional Policy Statement)
3. Auckland Council Regional Plan: Coastal (2004) – (Regional Plan: Coastal)
4. Auckland Council District Plan: Rodney Section (2000) – (Operative District Plan)

An example of one of the objectives of the above documents relevant to coastal flooding is Auckland Council Regional Plan: Coastal *Objective 21.3.1: To control the use of land in the coastal environment to ensure the adverse effects of natural coastal hazards are avoided or mitigated.*

Council officer advice at the hearing was that little weight should be given to the objectives and policies in Part 2 Chapter C – 5.12 Natural Hazards of the Proposed Auckland Unitary Plan (Unitary Plan). This was because at the time of the hearing, the provisions of Part 2 Chapter C – 5.12 Natural Hazards of the Unitary Plan had not yet been heard by the Unitary Plan Independent Hearings Panel. These provisions were also land use provisions and the Council had notified the Unitary Plan on the basis that only regional council provisions would be immediately effective with most land use provisions having no legal effect until decisions on submissions were released. The Panel were,

however able to take the objectives and policies of the natural hazards section of the Unitary Plan into account. This advice was accepted by the commissioners.

2.3.2 ASSESSMENT OF COASTAL INUNDATION HAZARD

The commissioners decision found that the NZCPS, Regional Policy Statement and Regional Plan: Coastal require an assessment of coastal hazards be undertaken for new subdivision and that the effects of climate change were germane to that assessment. The commissioners were aware that subdivision approvals need to take into account a broad planning horizon that includes the consideration of hazard risks that have been identified but may not be realised for some years to come. Accordingly, they considered that assessment should take into account a planning horizon of at least 100 years and ensure that certain dynamic climatic and hydrological factors to be taken into account. This includes the latest sea level rise (SLR) projections. They considered that the relevant coastal hazard applying to the site relates to coastal inundation and the coastal inundation analysis contained in the NIWA 2013 report (NIWA, 2013) is consistent with this policy direction.

It was noted, however, that coastal inundation mapping has been done for two sea level rise projections – a 1 metre sea level rise and a 2 metre sea level rise. Whatever SLR figure is chosen will have a significant bearing on the inundation risk and choice of mitigation options. It was considered that it is more appropriate to use a more moderate 1m SLR projection as opposed to the more extreme 2m SLR projection for the following reasons:

- The 1m projection is consistent with the latest *"likely range of sea level rise in 2100 for the highest climate change scenario"* of the Intergovernmental Panel on Climate Change 5 (IPCC5) report (IPCC,2014) and is consistent with Council's own guidance on climate change (Auckland council,2014).
- The 2m scenario is a more extreme approach and is yet to be confirmed in the statutory planning framework.
- A 2m SLR projection is proposed in the Unitary Plan. However, it was assessed that little weight can be given to this Plan at the time of the hearing due to its infancy in the statutory process

Therefore, the finding was that the NIWA assessment for extreme tide, combined with storm surge, together with a 1m SLR represents the best practice estimate of coastal inundation risk at the subject site and which was consistent with the statutory documents including those policies referred to above.

At the consent hearing both the applicant and Council officers advised that if the hazard does occur, it is likely to be of a short duration as the flood waters would recede with the tide. As such, they advised that there would be little risk to human health or property if the minimum floor levels of habitable buildings are set above the expected flood inundation level. The advice was that housing will not get flooded and, while roads, footpaths and reserves would flood, access to and from the sites will be available after a few hours when the tide recedes. The conclusion from Council officers and the applicant was that if a minimum floor level is set above the flood height, then the risk of this inundation hazard can be avoided, remedied or mitigated.

Council engineers noted that with respect to assessing an appropriate tidal inundation level at the site based on the NIWA 2013 report that:

1. *Overflow of inundation water onto land bordering the Kaipara Harbour would have some effect on reducing the maximum tide level to below that listed in the September 2013 NIWA Report, but*
2. *The actual reduction in maximum tide level cannot be assessed without carrying out a detailed study which would be a very complex project.*
3. *The order-of-magnitude of the reduction in tide level would be expected to be somewhere around 200mm (as opposed to a metre say).*

In light of the NIWA's assessment with a 1m SLR it was recommended by Council officers that an appropriate minimum habitable floor level be set at 4.5m DoSLI. This is based on a freeboard of 200mm (Orewa's current standard) and the NIWA 2013 assessment of inundation less the 200mm reduction advised by Council engineers at the hearing.

When taking into account the results of the IPCC 5 report, the NIWA 2013 assessment and the Council engineer's advice at the hearing it was considered that setting house floor levels to 4.5 m DoSLI would mitigate the coastal inundation risks to houses within the subdivision to an acceptable level and that the proposed subdivision that is located in the coastal environment will not exacerbate the coastal hazard or create a new coastal hazard.

The commissioners, however, found that there is insufficient information provided by the applicant or Council officers regarding actual or potential adverse effects of coastal inundation on roads, footpaths and reserves for the 1% AEP event and more frequent events.

As a result of this the commissioners carried out some further evaluation of information provided by the applicant and Council officers through the hearing process.

This assessment is shown in Table 1 below.

Frequency (annual exceedance probability) **(average recurrence interval)**	**0.01** **(100 year)**	**0.1** **(10 year)**	**0.39** **(2 year)**
Coastal inundation flood level at subdivision, m DoSLI[1] (Note 1)	4.33	4.01	3.75
Depth of flood water over lower parts of roads, including entrance to subdivision on Chic Gardens extension (metres) Note 2	1.73	1.41	1.15
Depth of flood water over much of the roads (metres) Note 3	1.03	0.71	0.45

Notes
1. Methodology as used by Council officers, i.e. NIWA 2013 report 1% AEP levels plus 1m sea level rise – 200 mm spread (without any freeboard)
2. Road level 2.6 m DoSLI, from initial subdivision design
3. Road level 3.3 m DoSLI, from initial subdivision design

Table 1 Assessment of flood depths

The commissioners' decision noted that widely used engineering guidelines shows cars are unstable at water depths of between 0.3m and 0.45m. Flood water depths causing hazard to pedestrians range from approximately 0.3 m to 0.8 m (for flow velocities of 1.5 m/s down to 0.5m/s) for adults and at lower depths for children. From the information supplied through the hearing process and shown in Table 1, flooding of roads, footpaths and reserves would be considerably more frequent than a "rare" 100 year flood event and would occur over much of the roads in a 2 year flood event to a predicted depth of 0.45m. This raised considerable concerns for the Commissioners over expected levels of amenity as well as for public health and safety that had not been assessed through the evidence presented at the hearing.

The New Zealand Standard for Land Development and Subdivision Engineering, NZS 4404:2004 section C4.3.2.4 states:

> *the standard recommended for ponding or secondary flow on roads is that they are passable to light vehicles in the 2% annual exceedance*

[1] Methodology as used by Council officers, i.e. NIWA 2013 report 1% AEP levels plus 1m sea level rise – 200 mm spread (without any freeboard)

probability (AEP) event (i.e. 50 year event) and to 4WD vehicles in the 1% AEP event).

It was also noted that Auckland Transport uses the Austroads Guide to Road Design, including Part 5B Drainage. Section 4 of this document discusses the design of parts of roads that are designed to be overtopped by floodwaters, i.e. floodways as follows:

- *The risk of cars being washed off floodways is an important consideration. Risk increases when total head of water (static plus velocity head) over the road surface is 300 mm or more. Road closure should be considered when the total head at any point on the road surface reaches 300mm; and*

- *The flows over the floodway should also be assessed for suitability for people who may attempt to traverse the flow on foot (e.g. vehicle occupants leaving their vehicle)*

The above demonstrated to the commissioners that coastal inundation water depths were:

- Significant and in excess of generally accepted safety guidelines for vehicles, pedestrians and children in the 100 year event based on flood level analysis by council officers;

- Likely to be significant and in excess of generally accepted safety guidelines for vehicles, pedestrians and children for the 10 year event; and

- Likely to be significant and in excess of guidelines for safe road use for motor vehicles, pedestrians and children for the more regular 2 year flood events.

The commissioners concluded that the adverse effects of coastal inundation had not been adequately avoided, remedied or mitigated and this was a sufficient basis for refusing consent for the subdivision. For these reasons it was found that the proposed subdivision had adverse effects that are significant and unacceptable on amenity values and on public health and safety. Further it was found that this outcome is not consistent with the various objectives and policies of the relevant operative statutory documents as set out above.

It was noted in the commissioners' decision that the applicant could undertake further investigations and revise the proposal to address this issue and this may include providing additional fill to mitigate the flood risk to the road, footpath and reserve areas in addition to the dwellings. However, this would require additional technical assessment on the displacement effects of additional filling and its impact on other areas also subject to the flood risk. As the commissioners did not have that information before them (including any implications regarding flood water displacement effects to other sites) they could not make an assessment either way on the viability of any revised option.

The decision of the commissioners was thus to refuse consent knowing that the applicant had an opportunity to revise the proposal under appeal to the Environment Court.

The reasons for this decision are as follows:

1. In terms of section 104D(1)(a) of the Resource Management Act 1991 ("RMA"), the adverse effects of the activity on the environment will be more than minor with regard to the adverse effects from an identified coastal inundation flooding hazard on the road, footpath and reserve areas of the proposed subdivision.

2. In terms of section 104D(1)(b) of the RMA, the application will be contrary to the objectives and policies of the Operative District Plan and the Regional Plan: Coastal with regard to the identified coastal inundation flooding hazard.

3. The proposal is inconsistent with Part 2 of the RMA and in particular its purpose as its failure to adequately address the effects of coastal inundation will not promote the sustainable management of natural and physical resources. While the proposal would provide much needed affordable housing in Parakai it fails to provide appropriate levels of amenity and public safety for residents associated with the coastal inundation flooding hazard.

2.4 APPEAL AND CONSENT ORDER

The applicant appealed to the Environment Court in March 2015 the Council's decision to refuse the consent, seeking that the court grant consent to the Proposal. The notice of appeal set out a number of reasons for the appeal including that any potential effects are minor and short term in duration.

Following court assisted mediation between the parties to the appeal which were the appellant and Council, (Council being represented by engineering and planning staff and legal counsel), the appellant agreed to undertake further investigations to determine whether the road levels could be raised to accommodate the costal inundation concerns expressed in the Council decision to refuse consent. It was agreed between the parties that:

- The roads do not need to be passable to vehicles as there would be nowhere for any vehicles to travel to outside of the raised development

- The reserve lots do not need to be protected from inundation events as it would be extremely unlikely these lots would be in use during such a storm event and users could easily move to the raised public roads

The appellant subsequently provided additional information, the parties undertook further analysis and the parties then agreed, subject to the Court's approval, that the appeal could be resolved by consent with a proposed resolution with the following key points of agreement:

- The minimum road level is to be (sic) maximum 500 mm water depth during 1% AEP event plus 1 m sea level rise less 200 mm attenuation. This equates to an overall minimum RL on the roads within the development of 3.8 m. The parties to the appeal considered that this addressed the concerns held by the commissioners for the consent hearing in relation to the coastal inundation hazard

- The minimum ground level on the sites within the development (including building platform and surrounding area) is to be 2% AEP plus 0.5 m sea level rise less 200 mm attenuation, which equate to RL 3.8 m

- Any buildings erected shall be subject to a minimum habitable floor level not lower than RL4.5m. This includes an allowance for 1 m for sea level rise, reduction of 200mm in the NIWA 2013 1% AEP inundation level due to flow spreading plus a freeboard of 200 m, which was considered acceptable in the original consent decision report.

The above agreements were noted in a Memorandum of Consent prepared in August 2015. It noted that the appellant provided updated ground contour and cut/fill plans to reflect the above requirements and the amendments will result in an additional 25,760 m^3 of clean fill being brought into the site, increasing the from 42,240m^3 in the refused proposal to 68,000 m^3.

The Environment Court subsequently granted consent by way of a Consent Order for the proposed development as amended by proposed additional filling described in the Memorandum of the Parties in Support of Draft Consent Order.

3 ASSESSING FLOOD HAZARD FOR COASTAL INUNDATION

3.1 GENERAL

The New South Wales Government Floodplain Development Manual for the Management of Flood Liable Land (NSW, 2005) defines hazard as a source of potential harm or a situation with a potential to cause loss. The discussion in this paper focusses on coastal inundation flood hazard with respect to life and health, rather than consideration of loss or damage to property or ecological components of the environment.

For this paper the primary methodology considered for assessing flood hazard is that contained in the NSW Government Floodplain Development Manual (NSWGFPDM), (NSW, 2005). This manual is primarily aimed at carrying out risk management for a whole floodplain, rather than separate individual development, however its discussion of flood hazard is in the author's opinion relevant to this paper, i.e. in consideration of an individual subdivision. The flood hazard assessment part of the manual is used by some Councils in New Zealand.

The NSW Government Floodplain Development Manual (NSW, 2005) recommends initial hazard categorization on hydraulic considerations alone followed by consideration of other factors that affect flood hazard. The figures used for initial categorization on hydraulic considerations are reproduced as Figures 3 and 4 below.

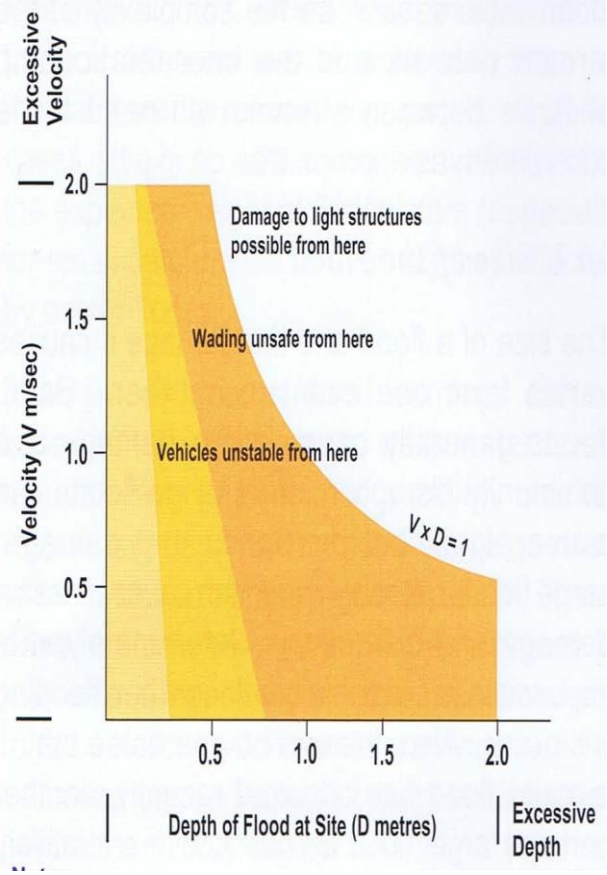

Figure 3 Velocity and Depth Relationships

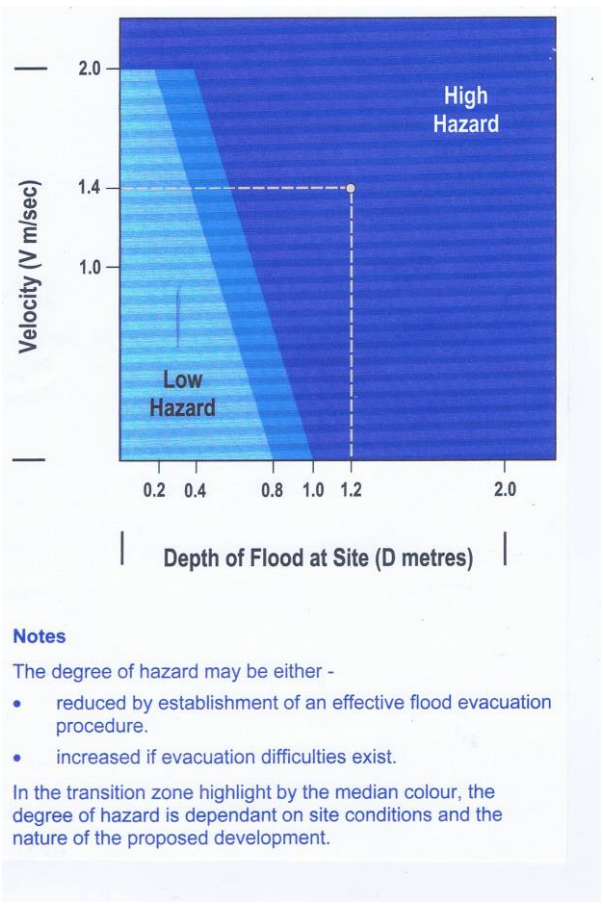

Figure 4 Provisional Hydraulic Hazard Categories

The NSW flood manual notes that the provisional hazard categorization based on hydraulic evaluations should be used with a number of other factors to determine the true hazard categories.

The other factors are:

- Size of flood
- Effective warning time
- Flood readiness
- Rate of rise of flood waters
- Depth and velocity of flood waters
- Duration of flooding
- Evacuation problems
- Effective flood access
- Type of development

3.2 FLOOD HAZARD FOR CONSENTED SUBDIVISION

An assessment of the maximum flood depth for a range of flood probabilities for the existing situation (no sea level rise) and with an allowance for 1 m sea level rise for the proposed subdivision with increases road and building site levels as set out in the consent order is shown in Table 2.

	Present day (no allowance for seal level rise)			**Future (with allowance for 1 m sea level rise)**		
Frequency (annual exceedance probability) (ARI - average recurrence interval)	**0.01 (100 year)**	**0.1 (10 year)**	**0.39 (2 year)**	**0.01 (100 year)**	**0.1 (10 year)**	**0.39 (2 year)**
Coastal inundation flood level at subdivision, m DoSLI1 (Note 1)	3.33	3.01	2.75	4.33	4.01	3.75
Maximum depth of flood water over roads and building platforms (metres) (Note 2)	nil	nil	nil	0.53	0.21	nil

Notes

(1) Methodology as used by Council officers, i.e. NIWA 2013 report 1% AEP levels plus 1m sea level rise – 200 mm spread (without any freeboard)

(2) Road level min 3.8 m DoSLI

Table 2 Flood Levels and Depths for consented subdivision

Provisional hazard categorization based on hydraulic evaluation cannot be accurately carried out as there is no information on flood velocities. Figure 3 above indicates vehicles may be unstable for depths over 300 mm even in still water. Figure 4 indicates the hazard may be low for a flood depth of 500 mm if the flood flow velocity is less than 1 m/second. The NSW Flood Manual (NSW, 2005) defines a low hazard as should it be necessary, a truck could evacuate people and their possessions; able bodied adults would have little difficulty in wading to safety. Our conclusion is that given uncertainty regarding flood flow velocities it is not possible to confidently set a provisional hazard categorization base on hydraulic evaluation.

For the proposed subdivision a discussion of factors to be considered other than hydraulic evaluations, in order to determine the true hazard categories, is as follows, based on the NSW Flood Manual approach.

- Size of flood – this is related to flood frequency large floods occurring less frequently than small floods; Table 2 shows that flood depths for a 10year ARI event with sea level rise is 0.21 metres which is unlikely to cause a hazard

- Effective warning time - given that the coastal inundation is due to a combination of high astronomical tide and storm surge caused by high winds it is possible to provide warning through civil defence mechanisms. As coastal inundation is only predicted to be a problem some distance in the future, there is time for implementation of civil defence mechanisms to provide adequate warning to residents of a large flood event; note that this assumes flood warning is an appropriate tool to mitigate hazard; our view is that it may not be when consenting green fields development

- Flood readiness – this includes flood education of residents and developing community awareness and readiness for floods with appropriate action set out. For the proposed subdivision this would include explaining that in a significant event houses are expected to be above flood levels but surrounding land will be inundated making evacuation difficult; this will depend on the composition of residents. For example elderly or infirm people may become very stressed and in the event of a large flood event which surrounds their house with water, may want or need to be evacuated.

- Rate of rise of flood waters – based on evidence from council engineers at the consent hearing that the total duration of flooding is related to the tidal cycle then floodwater would rise over approximately 1 to 1.5 hours;

- Depth and velocity of flood waters – this has been addressed under initial categorisation using hydraulic evaluation above;

- Duration of flooding- evidence at the consent hearing from Council engineers was that flooding would be short lived, i.e. 2 to 3 hours;

- Evacuation problems - once flood water are over 300 mm deep evacuation by road can only be done by a truck or similar; there is higher ground a few hundred metres to the west of the site along Fordyce Road;

- Effective flood access – this means an exit route that remains trafficable for sufficient time to evacuate people and possessions, or any other appropriate boat based or air based means of evacuation[2]. This could be addressed through civil defence mechanisms; and

- Type of development- this can include special evacuation needs, e.g. old or infirm people, children, level of occupant awareness; the type of resident of the proposed subdivision is not known at this stage but given it is aimed to provide low cost housing it is probably reasonable to expect some residents would be old, infirm people, or children

In summary the above discussion indicates that it is not possible to assess a robust flood hazard classification for the proposed subdivision due to:

- Inability to assess a provisional hazard categorization based on hydraulic evaluation for vehicles parking or travelling on the roads and pedestrians walking on the roads due to a lack of information on flood velocities at the subdivision

- Uncertainty regarding factors other than hydraulic evaluation as follows:

[2] Section L6.8 in NSW, 2015

- Flood readiness – appropriateness of a new subdivision over which significant spread of floodwater will occur in an extreme event with associated possible adverse effects on the emotional wellbeing of residents, in particular older or infirm residents

- Effective flood access – if access was required at or close to the occurrence of peak flood levels in an extreme event a large vehicle such as a truck would be required.

4 CONCLUSIONS

Our conclusions and recommendations from the above discussion with respect to assessing acceptable coastal flood hazard for subdivisions are:

- Robust flood level and flood velocity site-specific information is necessary to carry out preliminary hazard categorization based on hydraulic evaluation. While this often requires complex and time consuming modelling, given the extent of and importance of addressing the flood hazard for residential subdivisions, we consider such modelling should be carried out as part of an assessment of effects for resource consent applications for proposed coastal developments affected by coastal inundation. We note that the above suggested modelling should also be carried out to assess the effect on flood levels and velocities adjacent to a proposed development if large volumes of fill are to be placed on the site as part of the construction of the subdivision. A range of factors other than hydraulic evaluation are required to determine the true hazard categories; these are set out in Appendix L of the NSW Flood Manual and as a minimum should include:

    - Flood warning - ability to provide effective warning

    - Flood readiness – includes flood education of residents and developing community awareness and identification of vulnerable residents

    - Effective flood access – nature and practicality of access during occurrence of a flood, including for evacuation of vulnerable persons

    We consider the above factors should be considered within the flood hazard categorization as part of an assessment of effects for resource consent applications for proposed coastal developments affected by coastal inundation. It is acknowledged that consent conditions for subdivision are not able to address all such issues. This is exacerbated by future owners of the individual subdivided lots possibly being unaware of subdivision consent conditions. This means they may not be advised of the flood risk by the seller of the lots. This is often more likely when the dwelling is rented. It is our view that consent authorities need to be satisfied that the assessment of these flood hazard factors by an applicant is reasonable and consistent with current or likely future community health and safety regulations or initiatives (e.g. civil defence). We also believe that consent authorities should consider the use of consent notices on titles issued notifying the flood risk to the land owner

    Any determination of whether flood hazard is acceptable for proposed new subdivisions should use the above described hazard assessment method together with consideration of the guidance provided by relevant planning instruments and flood management experience elsewhere in New Zealand and worldwide.

    One relevant planning instrument is, Objective 7.4.10(3) of the Auckland Council Regional Policy Statement (RPS):

A precautionary approach shall be taken by local authorities when providing for and assessing subdivision, use and development in the coastal environment where potentially significant adverse effects may arise. (The precautionary approach is outlined in Chapter 1 – Introduction.)

In Section 1.10 of the RPS in discusses the precautionary approach as follows:

Where there is reason to believe that any adverse effects, including cumulative effects, that may arise from a proposed activity may be significant but those potential effects cannot be fully assessed due to inadequate information or understanding of these effects on the environment, then a precautionary approach should be taken. In such situations, when making decisions about managing the use, development or protection of natural and physical resources, local authorities should consider such options as (inter alia*):*

- *Declining or limiting the duration of a consent, or requiring a review during the period of the consent so that the results of monitoring can be considered Taking account of the level of uncertainty about the nature, extent, intensity and duration of potential adverse effects in classifying activities*

We note that we consider the precautionary principle should be used regarding sea level rise as estimates of sea level rise are continuing to be revised upwards.

Recent experience in the UK supports using a precautionary approach for flood aspects of urban planning. In Reddish,2014 the author, who has had UK flood management experience, states that we should be applying a precautionary approach and we should seek to avoid development in flood risk areas. He concludes that land use planning still offers significant opportunity for us to learn from overseas experience and ultimately limit the level of risk we expect our future communities to live with.

ACKNOWLEDGEMENTS

Thanks to Stephen Knight-Lenihan for his review and comments.

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