

MEMORANDUM

To:	Urbis
Date:	04/06/2024
Project Number:	7493
Project Name:	11 Harp St Campsie
Subject:	Updated Flood Advice, 2023
Version	2.0

Introduction:

Indesco have been engaged by Urbis and their client to provide a flood statement to support the planning proposal at 11 Harp St Campsie NSW.

The purpose of this memorandum is to provide updated advice regarding the flood affectation of the above site and commentary on consistency with NSW flood risk planning policies and documentation.

The site is located within the study area for the report entitled 'Canterbury LGA Cooks River Catchment, Final Overland Flow Study' (*Cardno, 19 April 2016*) (the 'Flood Study').

The Flood Study identifies that the site is subject to flooding in 1% AEP flood events and as such the considerations of the NSW Flood Prone Land Policy are applicable to the development.

Legislation and Guiding Documents:

This Technical memorandum is undertaken with reference and where appropriate response to the following key documents:

- Cooks River Floodplain Risk Management Study and Plan - Report – Canterbury Bankstown Council, February 2018.
- State Environmental Planning Policy Amendment (Flood Planning) 2023.
- Canterbury-Bankstown Local Environmental Plan 2023.
- Canterbury-Bankstown Development Control Plan 2023 - Section 2.2 Flood Risk Management.
- Flood Risk Management Manual, DPE, June 2023.
- Delivery under the Flood Risk Management Framework, DPE, June 2023.
- Flood Risk Management Measures, DPE, June 2023.
- Floodplain Risk Management Guide, DPE, January 2019.
- Flood Risk Management Guidelines, DPE, June 2023.
- The Floodplain Development Manual – The management of Flood Liable Land, April 2005.
- Australian Rainfall and Runoff, Commonwealth of Australia (Geoscience Australia), 2019.

Development proposal:

Several development proposals have been put forward incorporating Hospital, Medical Hotel, and an integrated ambulatory Health Hub, Day Procedure Centre and Clinical Support. An example of the development proposals is included below, refer to planning documents for further information.

- Access and egress to the development is proposed through Elizabeth St and Harp St, with configurations varying between development proposal scenarios. Secondary access is proposed from either 5 Elizabeth St (Lot 1051/DP789344) or 11A Elizabeth St (Lot 14/DP262535). These will be provided to support both one way and two-way traffic as well as pedestrian access/egress.

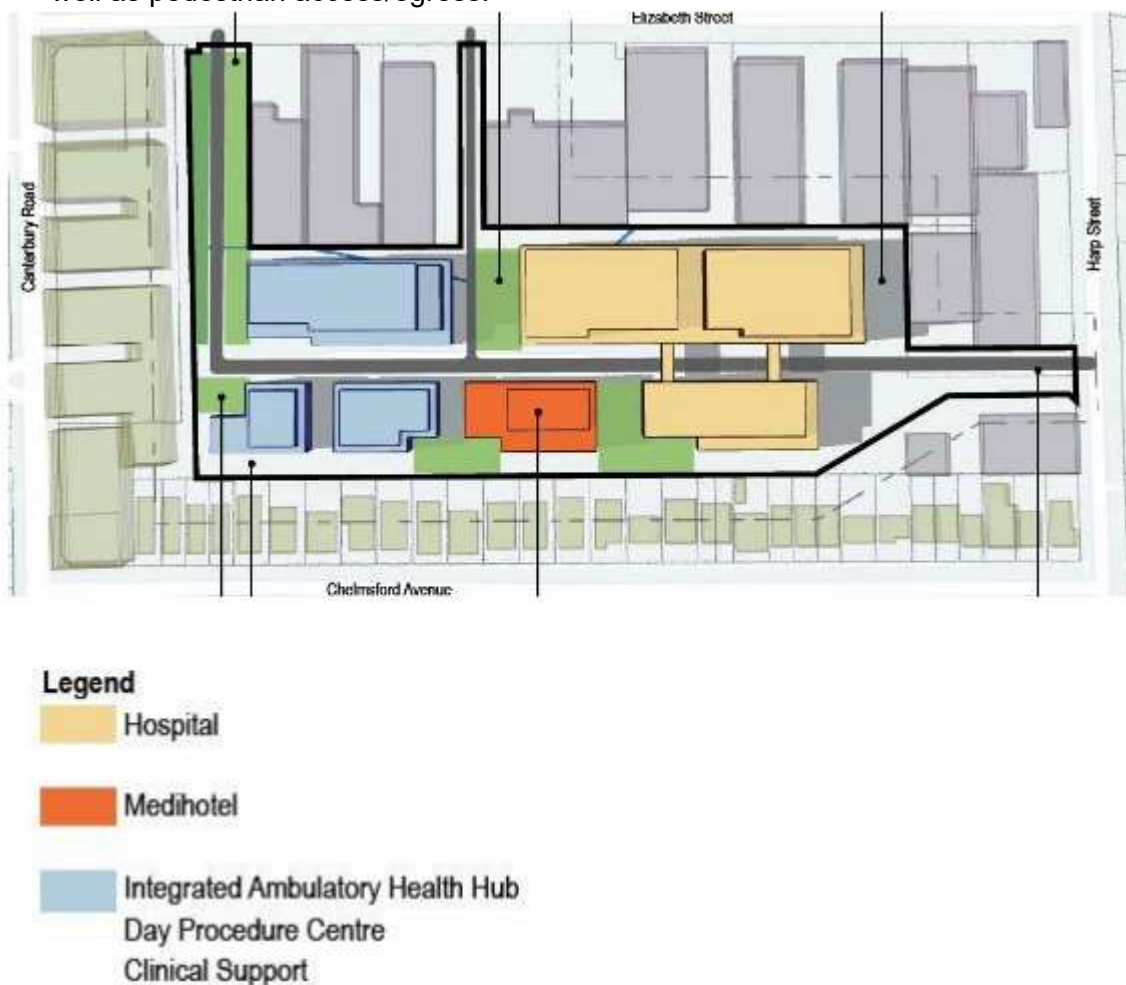


Figure 1 – Development Proposal, Urbis

Flooding Conditions:

The relevant flooding conditions impacting the site are:

- Harp St, which provides the primary access to the site in some of the development scenarios has been documented to be inundated by up to 750mm depth of flow in 1%AEP events.
- In 1% AEP flood events, Harp St will experience periods of H2 hazard (unsafe for small vehicles) for approximately 80 minutes, and H3 hazard (unsafe for large vehicles) for 60 minutes which will restrict safe vehicular access and egress to the site for periods of time for cars and emergency services vehicles accordingly.
- It is evident in comparing the proposed masterplan and site topography that buildings are not proposed to be located immediately adjacent Harp Street, and there is approximately 12m of available vertical difference between Harp Street and the majority of the development footprint providing ample clearance to all flood conditions.
- The flood study demonstrated ponding occurring within the site due to the existing topographical conditions noting the lidar digital elevation model shows a local low point of approximately RL34 AHD substantially lower lying than surrounding land.
- A significant flow path through the site was not identified as the majority of the site is situated substantially higher than Harp St.
- As the site is not within a substantial overland flow path topographical changes to the site are unlikely to affect neighbouring or downstream properties.
- Any potential increase in offsite flow will be managed through local infrastructure and on site detention provisions.



Figure 2 – Lidar Digital Elevation Model, ELVIS 2023

The flood study 'Canterbury LGA Cooks River Catchment, Final Overland Flow Study' (*Cardno, 19 April 2016*) (the 'Flood Study') completed by Cardno undertook a 1D-2D hydrological and hydraulic model using XP-Rafts for hydrology and Sobek software for hydraulic analysis. An excerpt from the study outlining the 1% AEP Flood Depth, Velocity and Hazard Category in the vicinity of the site are illustrated in figures 3-5.

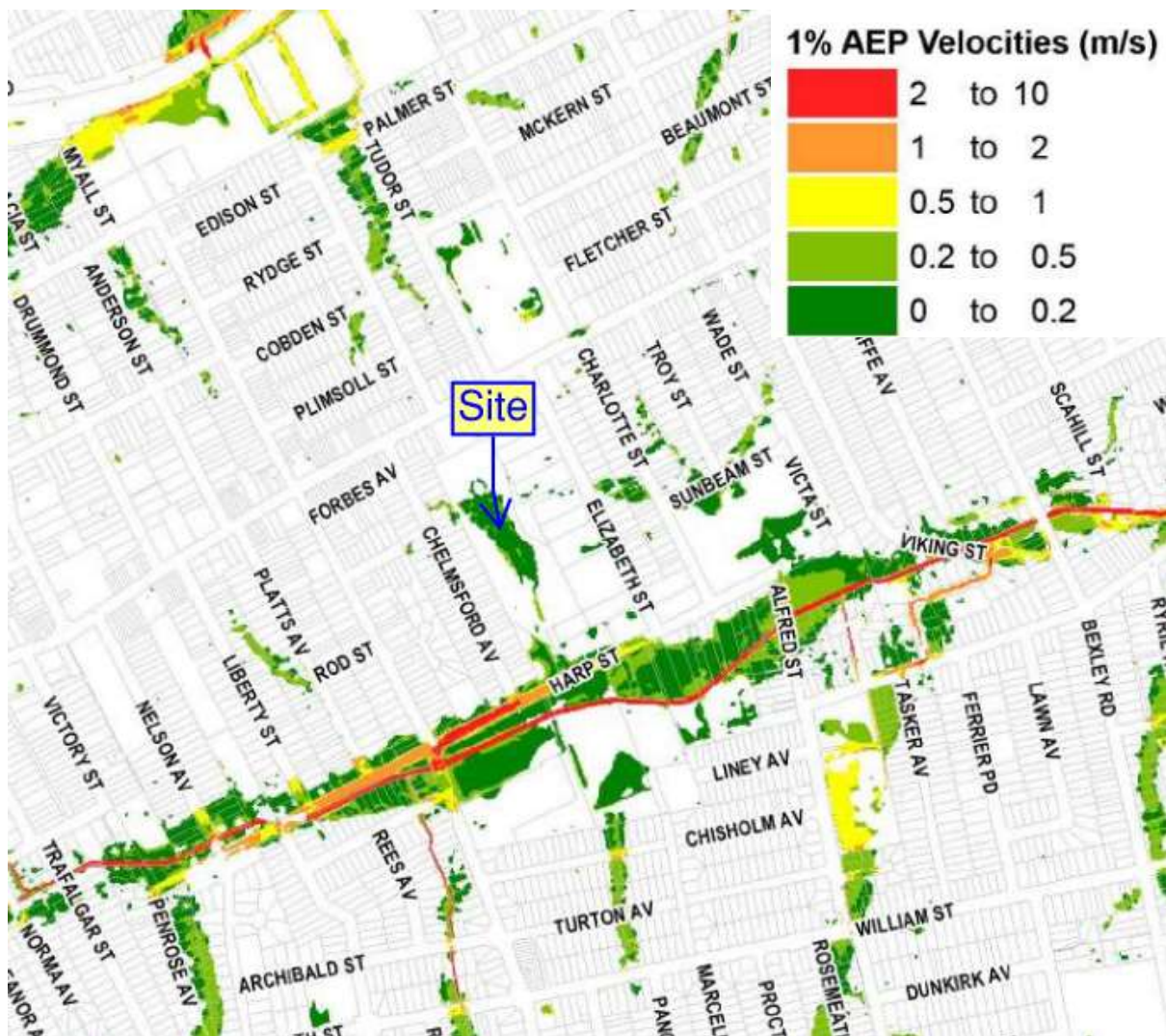


Figure 3 - 1% AEP Velocity Map Cardno 2016

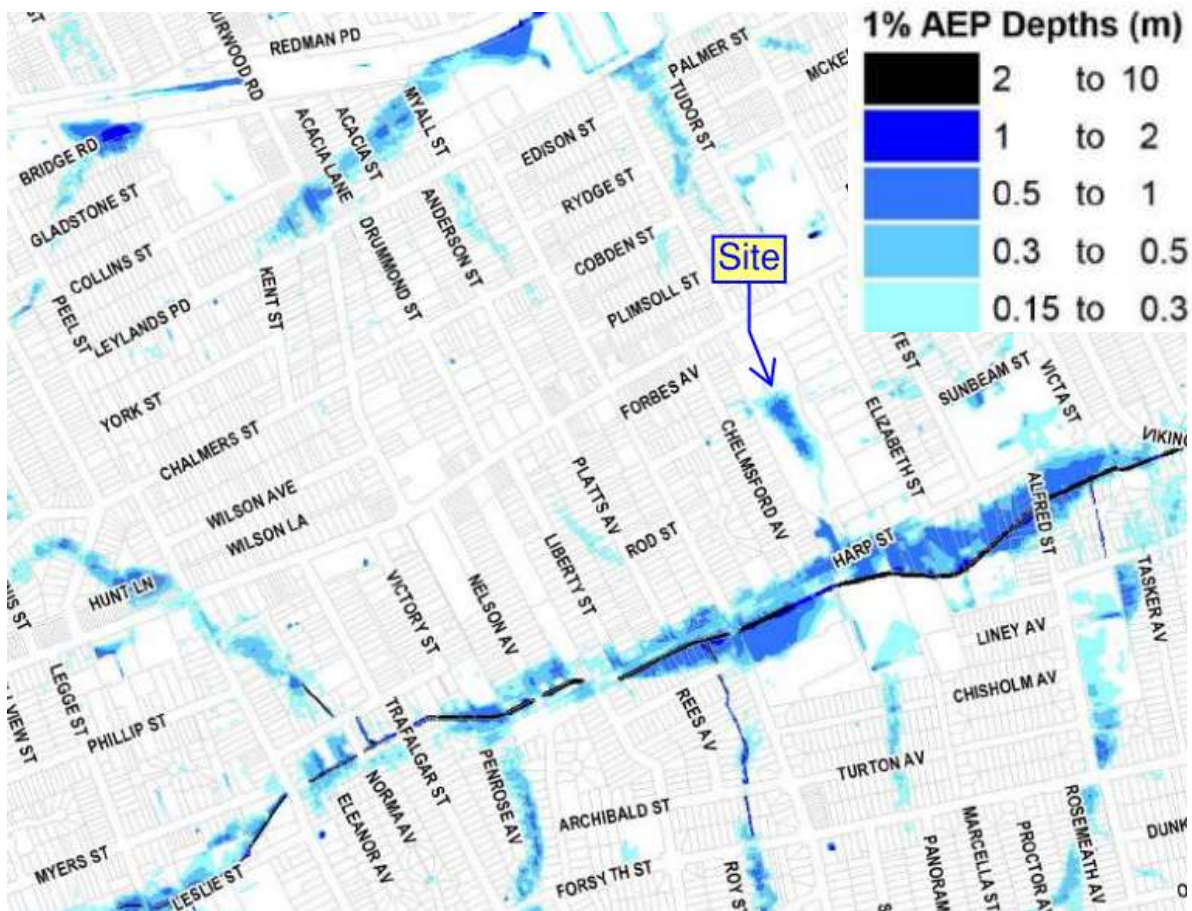


Figure 4 - 1% AEP Depth Map Cardno 2016



Figure 5 - 1% AEP Hazard Map Cardno 2016

Analysis of the provided flood mapping results indicate the site is not located within the primary flow path affecting Harp St, however is subject to ponding due to the site topography in 1% AEP storm events.

Analysis of the hazard categories affecting the site and surrounding roads has been undertaken.

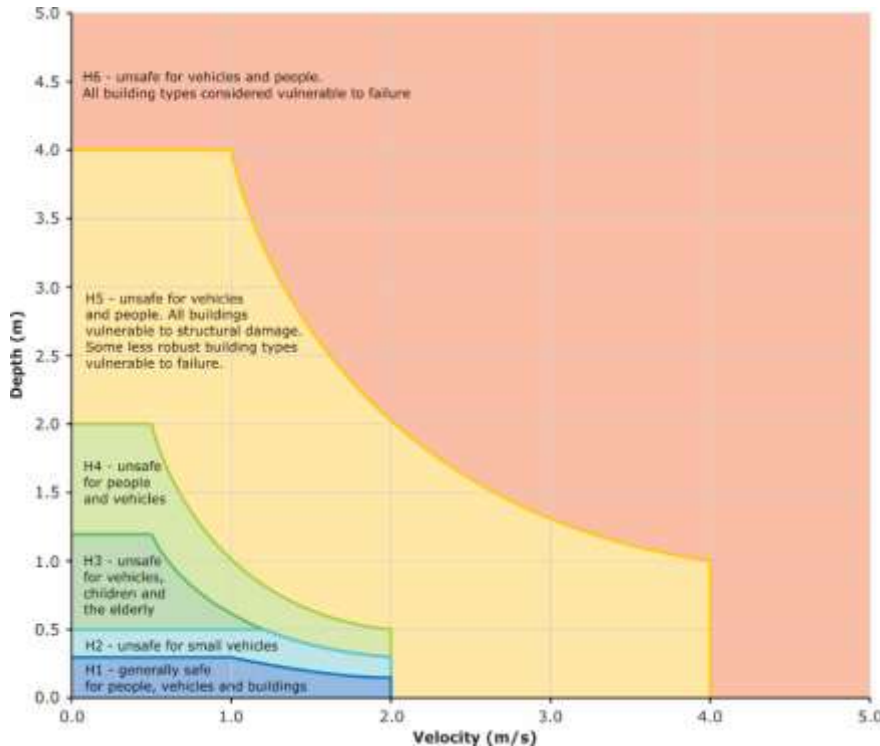


Figure 6: Flood Hazard Classification, Australian Rainfall and Runoff

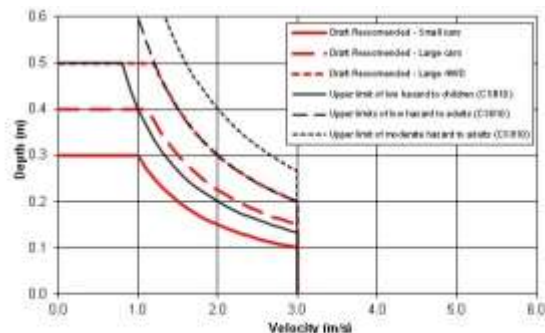


Figure 6.7.6. Interim Safety Criteria for Vehicles in Variable Flow Conditions (Shand et al., 2011)

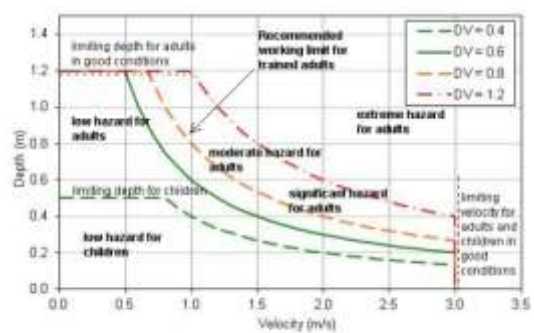


Figure 6.7.4. Safety Criteria for People in Variable Flow Conditions Cox et al. (2010)

Figure 7: Vehicle Stability and Personal Safety Graphs, Australian Rainfall and Runoff

Velocity within the proposed site is below 0.2m/s and depth below 1m representing trapped or pooling water rather than hazardous flow. As such the corresponding hazard category within the site is less than 0.4VD product and is considered safe for both persons and vehicles. Noting this value could be further reduced with effective grading and drainage of the site to prevent ponding.

Harp St is subject to both significant depths and velocities of overland flow owing to flows from Cup and Saucer Creek to the south of Harp St. This results in hazard category of H3 within Harp St adjacent the site entry.

Previous analysis of the council Sobek Model was provided by Indesco in 2020 and determined periods of hazard exceedance within Harp St as follows:

Table 1: Summary of Time Access Impacted Harp St (Indesco 2020)

	Time H1 Hazard Exceeded (minutes)	Time H2 Hazard Exceeded (minutes)
West		
90 minutes	75	55
120 minutes	75	60
East		
90 minutes	75	60
120 minutes	80	60

From the studies undertaken it can be concluded that:

- While the site has been identified as flood prone, the relevant flooding conditions affecting the site primarily impact vehicle access within Harp St and can otherwise be effectively controlled within the site for safe effective operation.
- During flood events Harp St access/egress shall have restricted use in accordance with a flood evacuation and management plan. As the 1%AEP event only lasts for 60 minutes in Harp St, it is considered appropriate that this plan shall reflect a shelter in place policy for all patients and non-emergency egress.

Flood Impact and Risk Assessment (FIRA).

Section 2.1 of the Flood Impact and Risk Assessment Management Guideline LU01 (DPE, 2023) identifies that the consent authority may require a FIRA when “*the proposed development could change flood behaviour, affect flood risk to the existing community or expose its users to flood risks that require management*”. In this instance at least one of those criteria are considered likely and Council should consider the need for a FIRA for this development.

It is recommended that discussions be held with Council to determine if a FIRA is considered necessary for this development, if so, it should be completed prior to the detailed design being finalised to ensure any required changes are considered in the final design.

Compliance with Development Controls

A Summary is presented as follows detailing the development having the ability to comply with the various flood planning development controls and goals.

Clause	Requirement	Compliance
DCP 3.1	The proposed development should not result in any significant increase in risk to human life, or in a significant increase in economic or social costs as a result of flooding.	The proposed development operating under a suitable shelter in place flood management plan and with provision for restricted access and egress via Elizabeth St does not result in any significant increase of risk of loss of human life, economic or social cost as a result of flooding. Structures are able to be adequately protected in 1% and above severity events and areas of risk within Harp St can be readily avoided.
DCP 3.2	The proposal should only be permitted where effective warning time and reliable access is available to an area free of risk from flooding, consistent with any relevant flood plan or flood evacuation strategy.	The site provides the option for evacuation via Elizabeth St or for safe shelter on site during a flood event. As such safety to users is provided.
DCP 3.3	Development should not significantly increase the potential for damage or risk other properties either individually or in combination with the cumulative impact of development that is likely to occur in the same floodplain.	The existing site is 100% impervious surface and is not located within a flow path. Total volume of runoff will not be increased by the development. To the extent flood conditions on adjacent properties may be modified by regrading of the site this can be effectively managed through site drainage and on site detention design during development.
DCP 3.4	Motor vehicles are able to be relocated, undamaged, to an area with substantially less risk from flooding, within effective warning time.	Motor vehicles are able to remain on site with an appropriate hazard category for safe storage or use. Alternatively access and egress are available via Elizabeth St should the need to evacuate arise.
DCP 3.5	Procedures would be in place, if necessary, (such as warning systems, signage or evacuation drills) so that people are aware of the need to evacuate and relocate motor vehicles during a flood and are	As shelter in place is a suitable management procedure for the proposed site further evacuation planning can be limited to informing users through signage or briefings to

	capable of identifying the appropriate evacuation route.	utilise Elizabeth St rather than Harp St in the event of a flood, or to remain on site.
DCP 3.6	To minimise the damage to property, including motor vehicles arising from flooding.	The site is elevated significantly above Harp St and is able to be readily protected from damage due to flooding. This is an ongoing consideration to be delivered in the detailed design of the site.
DCP 3.7	Development should not result in significant impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (e.g. by unsympathetic house-raising) or by being incompatible with the streetscape or character of the locality.	The site does not require substantial raising to achieve flood immunity as it is already several metres above Harp St. Freeboard can be achieved without having a relevant impact on overshadowing or the streetscape.
LEP 5.2.1a	To minimise the flood risk to life and property associated with the use of land,	No notable increase to flood risk is identified as a result of the proposed development. Shelter in place and evacuation via Elizabeth St are both effective and safe options in emergency response for the site.
LEP 5.2.1b	To allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,	The site is protected from overland flow paths and with appropriate design will require management only of access and egress in emergencies, which can be resolved through reasonable measures of shelter in place or restricted access.
LEP 5.2.1c	To avoid adverse or cumulative impacts on flood behaviour and the environment,	The site can manage all flows produced or interrupted by regrading through on site detention. No impact on downstream properties is required,
LEP 5.2.1d	To enable the safe occupation and efficient evacuation of people in the event of a flood.	Evacuation is not essential for the subject site, shelter in place provides reasonable protection to flooding. Alternatively safe evacuation is also viable through Elizabeth St.
Ministerial Direction Part 4.1.1	A planning proposal must include provisions that give effect to and are consistent with:	The proposed development is able to comply with the provisions of the NSW Flood Prone Land Policy, the Floodplain

	<p>(a) the NSW Flood Prone Land Policy, (b) the principles of the Floodplain Development Manual 2005,</p> <p>(c) the Considering flooding in land use planning guideline 2021, and</p> <p>(d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.</p>	<p>Development Manual and the Land Use Planning Guideline.</p> <p>The proposed site is able to be developed consistent with the goals of reducing the impact of flooding and flood liability on owners and occupiers of flood prone land, and to reduce public and private losses resulting from floods whilst utilising ecologically positive methods wherever possible.</p> <p>The site is able to be delivered above the 1% AEP level with appropriate freeboard, and safe options for sheltering on site or evacuating are available to users.</p>
Ministerial Direction Part 4.1.2	A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones	Complies.
Ministerial Direction Part 4.1.3	<p>A planning proposal must not contain provisions that apply to the flood planning area which:</p> <p>(a) permit development in floodway areas,</p> <p>(b) permit development that will result in significant flood impacts to other properties,</p> <p>(c) permit development for the purposes of residential accommodation in high hazard areas, (d) permit a significant increase in the development and/or dwelling density of that land,</p> <p>(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,</p> <p>(f) permit development to be carried out without development consent except for the purposes of exempt development or</p>	<p>Complies</p> <p>(a) not proposed</p> <p>(b) Impacts to adjacent properties can be effectively managed through provision of OSD and detailed drainage design and grading.</p> <p>(c) Residential development not proposed</p> <p>(d) N/A</p> <p>(e) Safe sheltering on site or evacuating are both possible in the proposed facility using Elizabeth St rather than Harp St. This responds effectively to the nature of the proposed medical facilities.</p> <p>(f) N/A</p> <p>(g) N/A no increase in government spending anticipated as site is able to be effectively self managed through sheltering or evacuation via Elizabeth St.</p> <p>(h) N/A not proposed.</p>

	<p>agriculture. Dams, drainage canals, levees, still require development consent,</p> <p>(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or</p> <p>(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.</p>	
Ministerial Direction Part 4.1.4	<p>A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which:</p> <p>(a) permit development in floodway areas,</p> <p>(b) permit development that will result in significant flood impacts to other properties,</p> <p>(c) permit a significant increase in the dwelling density of that land,</p> <p>(d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,</p> <p>(e) are likely to affect the safe occupation of and efficient evacuation of the lot, or</p> <p>(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.</p>	<p>Complies</p> <p>(a) Not proposed.</p> <p>(b) Impacts to adjacent properties can be effectively managed through provision of OSD and detailed drainage design and grading.</p> <p>(c) Residential development not proposed</p> <p>(d) Safe sheltering on site or evacuating are both possible in the proposed facility using Elizabeth St rather than Harp St. This responds effectively to the nature of the proposed medical facilities.</p> <p>(e) N/A site currently utilised as a car park. Evacuation not affected by proposal.</p> <p>(f) N/A no increase in government spending anticipated as site is able to be effectively self managed through sheltering or evacuation via Elizabeth St.</p>

While the development is subject to ongoing design it is our opinion that all requirements and provisions of the flood risk management guiding documents and legislation are able to be met on the site with appropriate design considerations.

Site Specific Development Control Plan

As part of the next stage of planning and development, a site specific DCP will be required to be prepared in line with the council recommendations.

This DCP will be similar in content to the recent DCP prepared for 445 Canterbury Road in relation to the Harp Street flooding interaction.

Key elements regarding flood management that must be provisions in the DCP including:

- Detailed objectives ensuring flood resilience of the property, sound WSUD principles, and water quantity management.
- A flood impact and risk assessment and site stormwater strategy assessment is to be undertaken determining the risks and appropriate design event including 1% AEP and potentially up to PMF conditions.
- A flood emergency response plan is to be prepared, which given the nature of the proposed development and topographical conditions will seek to demonstrate a shelter in place policy to be effective.
- Updating of flood modelling and assessment undertaken to date to reflect final design surface levels, updated mapping standard practices, and climate change conditions.
- Requirements for on site detention to ensure no impacts to adjoining properties or downstream conditions.
- Water cycle management to incorporate principles of on site capture storage reuse and infiltration of stormwater

Conclusion and Recommendations:

The site is currently affected by flooding within Harp St and ponding within the site due to the existing topography providing ineffective drainage.

In our opinion the site presents a suitable development opportunity for the proposed use. Sufficient protection from flooding for users and the public can be achieved through effective design and grading of the site without impacting the surrounding community or properties.

It is evident in comparing the proposed masterplan and site topography that buildings are not proposed to be located immediately adjacent Harp Street, and there is up to 12m of available vertical difference between Harp Street and the majority of the development footprint providing ample clearance to all flood conditions.

- A site specific DCP is to be prepared in accordance with the council recommendations and the inclusions specifically relating to flooding noted in this memo.
- Emergency access and egress must be restricted to Elizabeth St during flood events.

- A minor overland flow path has been raised along Elizabeth St and requires design that mitigates this to be developed in detailed design.
- Site grading and drainage design is to resolve the ponding identified within the site.
- A broader precinct wide flood study is required for the Campsie Town Centre Masterplan. Any precinct wide flood study can incorporate current flood modelling and studies that have been undertaken prior to this proposal.
- A Flood Impact and Risk Assessment may be required to support the development proposal noting the requirement for restricted vehicular and personnel access to Harp St during flood events, and the level of protection offered in a shelter in place arrangement.
- Flow depths and velocities within Harp St reach levels that are not safe for persons or vehicles during 1% AEP events. Effective separation of people and vehicles from Harp St must be achieved in ongoing flood risk planning and management for the site.
- In order to effectively manage isolation periods resulting from flood events documented in our investigation, a Flood Emergency Response Plan would be required to be implemented into the proposed 11 Harp Street, Campsie – Health Precinct. A likely strategy to be pursued will require:
 - Strategy for diversion of inbound patients and emergency services to other nearby facilities;
 - Stay-In-Place procedures integrated into the precinct;
 - Site prepared to be self-sufficient for the duration of isolation; and
 - Potential helicopter evacuation for residents requiring unmanageable medical assistance.
- Further hydraulic modelling is likely to be required to reflect the final site topography as part of detailed design activities. The previous modelling has been undertaken using largely obsolete Sobek software, if required, an agreement with council should be sought to determine if future site-specific modelling will adopt the existing Sobek model or a broader precinct wide model should be undertaken using a more capable and standard industry software such as Tuflow.
- Site OSD design must be included to reflect no worsening of conditions to the surrounding area. This is considered readily achievable in the current site proposal.

In our view these safety measures and flood management strategies can be readily designed and implemented into the development during the design development process in collaboration with City of Canterbury-Bankstown Council and greater Council requirements.



Karl Martin

Senior Engineer

APPENDIX A - 7493 - 11 HARP STREET, CAMPSIE – PROPOSED HEALTH PRECINCT

Flood Study and Assessment – Technical Memorandum

04 August 2020

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Attention: Mr Michael Bugden

Dear Michael,

7483 - 11 HARP STREET, CAMPSIE – PROPOSED HEALTH PRECINCT

Flood Study and Assessment – Technical Memorandum

Project Background

Neetan and INDESCO attended a meeting with Council dated 27 April 2020 to discuss the stormwater issues and flooding constraints along Harp Street, Campsie.. Neetan and INDESCO proposed these conditions and restrictions were manageable on the basis that emergency vehicles would be able to access and egress the development when subject to a flood depth of up to 300mm, if considered H1 Flood Risk.

INDESCO have been required to undertake the required flood modelling and investigations in order to determine the duration of which the site would be isolated during these major events, particularly the 1 in 100 year flood event (1% Annual Exceedance Probability (AEP)).

This technical memorandum details the findings of the flood study and assessment derived from the SOBEK model files provided by City of Canterbury-Bankstown Council.

Flooding Investigation and Reporting Methodology

The following investigations were completed:

- Coordination with City of Canterbury-Bankstown Council via phone and email;
- Attainment, collation and detailed review/assessment of flooding information provided by City of Canterbury-Bankstown Council (+600GB of information required to be accessed and collected via external storage device from Council chambers);
- Review of the information concluded the information provided included maximum depth at the peak of the flood and not the flood depth at regular intervals during the flood, which is required to determine and derive durations of isolation of the site;
- Additional flood modelling using SOBEK software was required to re-run the modelling data and derive this information – SOBEK is an older software program that is no longer used by Council and only a handful of consultants;
- Re-run SOBEK model to generate the following flooding outputs to inform final assessment:
 - Revised 5 minute reporting increments;
 - Recording stations at locations of interest;
 - Model run for 90-minute and 120-minute 1% AEP events;
 - Updated time series at identified recording stations for depth, velocity and hazard category at each event; and
 - Duration of H1 and H2 flooding scenarios at previously identified recording station.
- Aiming for an outcome of an allowable 300mm depth for access; and
- Final reporting based on updated flooding outputs.

Model Outputs and Evaluation

The data was extracted from the revised SOBEK model, for which the only change made was the reduction of the reporting timestep to 5 minutes, and the addition of some recording stations along Harp Street.

After completing the pre-requisite coordination with Council and completing the required flood model runs, investigations and reporting, we have concluded the following:

- That during the 1% AEP event the site is subject to approximately 750mm of depth (High Hazard); and
- For 75 minutes access for small cars is cut off, and for 60 minutes access for larger cars is off. This is based on the depth / velocity chart below from Australian Rainfall and Runoff.

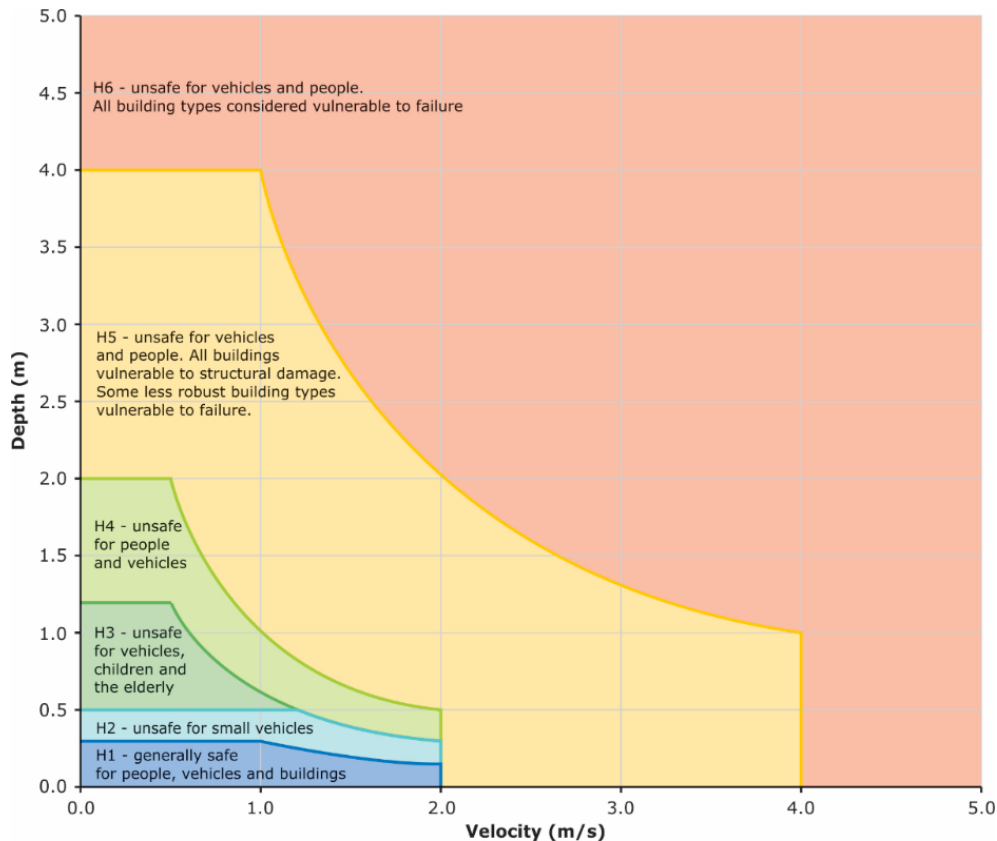


Figure 1: Flood Hazard Classification

Access from both the east and west along Harp Street was assessed. The results are very similar. Please see a summary below. The full time series is provided in the attached, along with the location for which the data was extracted.

Table 1: Summary of Time Access Impacted

	Time H1 Hazard Exceeded (minutes)	Time H2 Hazard Exceeded (minutes)
West		
90 minutes	75	55
120 minutes	75	60
East		
90 minutes	75	60
120 minutes	80	60

Conclusion

In conclusion to our extensive flood study and investigation, comprising of various coordination, modelling and reporting exercises in collaboration with City of Canterbury-Bankstown Council – it is our view that on the basis of the results attained from this investigation flooding impacts on the site can be safely managed.

In order to effectively manage isolation periods resulting from flood events documented in our investigation, a Flood Emergency Response Plan would be required to be implemented into the proposed 11 Harp Street, Campsie – Health Precinct. This Flood Emergency Response Plan would include the key-items for Council's further consideration and acceptance, comprising safety management and facilitation of residents during 90-minute and 120-minute events and recorded impacts on site access. These key-items include:

- Strategy for diversion of inbound patients and emergency services to other nearby facilities;
- Stay-In-Place procedures integrated into the precinct;
- Site prepared to be self-sufficient for the duration of isolation; and
- Potential helicopter evacuation for residents requiring unmanageable medical assistance.

In our view these safety measures and flood management strategies can be readily designed and implemented into the development during the design development process in collaboration with City of Canterbury-Bankstown Council and greater Council requirements.

Further Modelling Requirements

The 120 minute event has yet to finish running, but the data currently available was sufficient for determining the H1 and H2 exceedance periods. This is the reason the 120-minute data record is shorter than the 90-minute event in the spreadsheet.

Attachments

- **APPENDIX A: SOBEK 90-MINUTE AND 120-MINUTE DATA (EAST)**
- **APPENDIX B: SOBEK 90-MINUTE AND 120-MINUTE DATA (WEST)**

SOBEK DATA - EAST

1% AEP 90 minute			
Time H1 exceeded		75 minutes	
Time H2 exceeded		60 minutes	
Time	Depth (90m)	Velocity (90min)	Hazard Category
0	0	0	H1
5	5.66667E-07	0	H1
10	0.000510567	0	H1
15	0.07182393	0.06815052	H1
20	0.1166917	0.1871314	H1
25	0.1622583	0.1399284	H1
30	0.2027664	0.1166694	H1
35	0.3410781	0.2173885	H2
40	0.5033347	0.3826245	H3 or greater
45	0.6403428	0.5155171	H3 or greater
50	0.7165662	0.5836364	H3 or greater
55	0.7524502	0.6042742	H3 or greater
60	0.7807586	0.6304123	H3 or greater
65	0.7981051	0.637471	H3 or greater
70	0.8013818	0.6256115	H3 or greater
75	0.7894675	0.5908179	H3 or greater
80	0.7657669	0.5438652	H3 or greater
85	0.729252	0.47882	H3 or greater
90	0.6669698	0.3596233	H3 or greater
95	0.5799382	0.2324909	H3 or greater
100	0.4828492	0.1360046	H2
105	0.37041	0.04113498	H2
110	0.2912885	0.005566442	H1
115	0.2426492	0.009777197	H1
120	0.225705	0.006814648	H1
125	0.2192204	0.01099193	H1
130	0.2152945	0.009294807	H1
135	0.2120962	0.00775645	H1
140	0.2091612	0.006177366	H1
145	0.2063314	0.004667514	H1
150	0.2036191	0.003106829	H1
155	0.2010308	0.002066954	H1
160	0.1985321	0.000913403	H1
165	0.1961007	0.000597908	H1
170	0.1937142	0.001026041	H1
175	0.1914985	0.001621539	H1
180	0.1893243	0.00214144	H1

1% AEP 120 minute			
Time H1 exceeded		80 minutes	
Time H2 exceeded		60 minutes	
Time	Depth (120m)	Velocity (120m)	Hazard Category
0	0	0	H1
5	3.33333E-08	0	H1
10	3.00333E-05	0	H1
15	0.06176991	0.04015476	H1
20	0.08931497	0.1225359	H1
25	0.1141092	0.1440677	H1
30	0.1523538	0.1300649	H1
35	0.1831245	0.1159443	H1
40	0.2366084	0.03382423	H1
45	0.413583	0.2809419	H2
50	0.5694258	0.4531808	H3 or greater
55	0.6802126	0.5574563	H3 or greater
60	0.732095	0.5851169	H3 or greater
65	0.7649947	0.6052387	H3 or greater
70	0.7950179	0.6408507	H3 or greater
75	0.8060011	0.6390056	H3 or greater
80	0.8039157	0.6235832	H3 or greater
85	0.7897453	0.5843075	H3 or greater
90	0.7654408	0.5429767	H3 or greater
95	0.729306	0.4775426	H3 or greater
100	0.6670272	0.3607929	H3 or greater
105	0.584084	0.2395924	H3 or greater
110	0.4947424	0.1549628	H2
115	0.3962634	0.0687566	H2
120	0.3170843	0.02497292	H2
125	0.2669116	0.00855365	H1
130	0.237869	0.009094391	H1
135	0.2271936	0.005591757	H1
140	0.2216597	0.007676512	H1
145	0.2177227	0.007073625	H1

Hazard limits from AIDR Guideline 7-3

	VD Limit	D limit	V limit	
H1	0.3	0.3		2
H2	0.6	0.5		2

Location of Data Extraction

History station 20 in revised SOBEK model. Location shown below.
SOBEK model results indicated that this is the location at which road access if first lost in the east.



SOBEK DATA - WEST


1% AEP 90 minute			
Time H1 exceeded		75 minutes	
Time H2 exceeded		55 minutes	
Time	Depth (90m)	Velocity (90min)	Hazard Category
0	0	0	H1
5	5.66667E-07	0	H1
10	0.000510567	0	H1
15	0.02312112	0.09258647	H1
20	0.08050376	0.01934533	H1
25	0.1296873	0.05408799	H1
30	0.1714092	0.0723667	H1
35	0.3179966	0.4335138	H2
40	0.4781631	0.5678545	H2
45	0.608136	0.7167524	H3 or greater
50	0.6849199	0.764264	H3 or greater
55	0.7266672	0.7809484	H3 or greater
60	0.7556638	0.7928966	H3 or greater
65	0.7755539	0.7918459	H3 or greater
70	0.7798946	0.7625082	H3 or greater
75	0.7691195	0.7134283	H3 or greater
80	0.7457346	0.6492366	H3 or greater
85	0.7085323	0.5615052	H3 or greater
90	0.6446722	0.3979701	H3 or greater
95	0.5554444	0.2232398	H3 or greater
100	0.45483	0.1055076	H2
105	0.3394781	0.1216911	H2
110	0.2575784	0.177759	H1
115	0.208996	0.2024565	H1
120	0.1925521	0.1863364	H1
125	0.1862939	0.1761198	H1
130	0.18248	0.1662662	H1
135	0.1793789	0.1566458	H1
140	0.1764973	0.1473989	H1
145	0.1737335	0.13822	H1
150	0.1711232	0.1303559	H1
155	0.1686155	0.1237143	H1
160	0.1662042	0.1174297	H1
165	0.1638214	0.1116216	H1
170	0.1614792	0.1059385	H1
175	0.159322	0.1008634	H1
180	0.1571942	0.09632469	H1

1% AEP 120 minute			
Time H1 exceeded		75 minutes	
Time H2 exceeded		60 minutes	
Time	Depth (120m)	Velocity (120m)	Hazard Category
0	0	0	H1
5	3.33333E-08	0	H1
10	3.00333E-05	0	H1
15	0.02148671	0.08890267	H1
20	0.04170371	0.012267	H1
25	0.07952978	0.03078685	H1
30	0.1200681	0.0394689	H1
35	0.1506392	0.07920375	H1
40	0.2149659	0.1591284	H1
45	0.3888694	0.4714904	H2
50	0.5409656	0.6438704	H3 or greater
55	0.6469555	0.7488995	H3 or greater
60	0.7037343	0.7589924	H3 or greater
65	0.739655	0.7617067	H3 or greater
70	0.770847	0.7951857	H3 or greater
75	0.7846777	0.7875058	H3 or greater
80	0.7830778	0.7565746	H3 or greater
85	0.7700437	0.7023792	H3 or greater
90	0.7457028	0.647248	H3 or greater
95	0.7087268	0.5593641	H3 or greater
100	0.6448452	0.3999829	H3 or greater
105	0.5598406	0.2329754	H3 or greater
110	0.4678154	0.1242443	H2
115	0.3661035	0.101236	H2
120	0.2848607	0.1513715	H1
125	0.2327584	0.1998214	H1
130	0.2042138	0.2017522	H1
135	0.1939054	0.1905217	H1
140	0.1885901	0.1808896	H1
145	0.1848218	0.1720123	H1

Hazard limits from AIDR Guideline 7-3			
	VD Limit	D limit	V limit
H1	0.3	0.3	2
H2	0.6	0.5	2

Location of Data Extraction

History station 22 in revised SOBEK model. Location shown below.
SOBEK model results indicated that this is the location at which road access if first lost in the west.



SOBEK DATA - EAST

1% AEP 90 minute			
Time H1 exceeded		75 minutes	
Time H2 exceeded		60 minutes	
Time	Depth (90m)	Velocity (90min)	Hazard Category
0	0	0	H1
5	5.66667E-07	0	H1
10	0.000510567	0	H1
15	0.07182393	0.06815052	H1
20	0.1166917	0.1871314	H1
25	0.1622583	0.1399284	H1
30	0.2027664	0.1166694	H1
35	0.3410781	0.2173885	H2
40	0.5033347	0.3826245	H3 or greater
45	0.6403428	0.5155171	H3 or greater
50	0.7165662	0.5836364	H3 or greater
55	0.7524502	0.6042742	H3 or greater
60	0.7807586	0.6304123	H3 or greater
65	0.7981051	0.637471	H3 or greater
70	0.8013818	0.6256115	H3 or greater
75	0.7894675	0.5908179	H3 or greater
80	0.7657669	0.5438652	H3 or greater
85	0.729252	0.47882	H3 or greater
90	0.6669698	0.3596233	H3 or greater
95	0.5799382	0.2324909	H3 or greater
100	0.4828492	0.1360046	H2
105	0.37041	0.04113498	H2
110	0.2912885	0.005566442	H1
115	0.2426492	0.009777197	H1
120	0.225705	0.006814648	H1
125	0.2192204	0.01099193	H1
130	0.2152945	0.009294807	H1
135	0.2120962	0.00775645	H1
140	0.2091612	0.006177366	H1
145	0.2063314	0.004667514	H1
150	0.2036191	0.003106829	H1
155	0.2010308	0.002066954	H1
160	0.1985321	0.000913403	H1
165	0.1961007	0.000597908	H1
170	0.1937142	0.001026041	H1
175	0.1914985	0.001621539	H1
180	0.1893243	0.00214144	H1

1% AEP 120 minute			
Time H1 exceeded		80 minutes	
Time H2 exceeded		60 minutes	
Time	Depth (120m)	Velocity (120m)	Hazard Category
0	0	0	H1
5	3.33333E-08	0	H1
10	3.00333E-05	0	H1
15	0.06176991	0.04015476	H1
20	0.08931497	0.1225359	H1
25	0.1141092	0.1440677	H1
30	0.1523538	0.1300649	H1
35	0.1831245	0.1159443	H1
40	0.2366084	0.03382423	H1
45	0.413583	0.2809419	H2
50	0.5694258	0.4531808	H3 or greater
55	0.6802126	0.5574563	H3 or greater
60	0.732095	0.5851169	H3 or greater
65	0.7649947	0.6052387	H3 or greater
70	0.7950179	0.6408507	H3 or greater
75	0.8060011	0.6390056	H3 or greater
80	0.8039157	0.6235832	H3 or greater
85	0.7897453	0.5843075	H3 or greater
90	0.7654408	0.5429767	H3 or greater
95	0.729306	0.4775426	H3 or greater
100	0.6670272	0.3607929	H3 or greater
105	0.584084	0.2395924	H3 or greater
110	0.4947424	0.1549628	H2
115	0.3962634	0.0687566	H2
120	0.3170843	0.02497292	H2
125	0.2669116	0.00855365	H1
130	0.237869	0.009094391	H1
135	0.2271936	0.005591757	H1
140	0.2216597	0.007676512	H1
145	0.2177227	0.007073625	H1

Hazard limits from AIDR Guideline 7-3

	VD Limit	D limit	V limit	
H1	0.3	0.3	2	
H2	0.6	0.5	2	

Location of Data Extraction

History station 20 in revised SOBEK model. Location shown below.
SOBEK model results indicated that this is the location at which road access if first lost in the east.



SOBEK DATA - WEST

1% AEP 90 minute			
Time H1 exceeded		75 minutes	
Time H2 exceeded		55 minutes	
Time	Depth (90m)	Velocity (90min)	Hazard Category
0	0	0	H1
5	5.66667E-07	0	H1
10	0.000510567	0	H1
15	0.02312112	0.09258647	H1
20	0.08050376	0.01934533	H1
25	0.1296873	0.05408799	H1
30	0.1714092	0.0723667	H1
35	0.3179966	0.4335138	H2
40	0.4781631	0.5678545	H2
45	0.608136	0.7167524	H3 or greater
50	0.6849199	0.764264	H3 or greater
55	0.7266672	0.7809484	H3 or greater
60	0.7556638	0.7928966	H3 or greater
65	0.7755539	0.7918459	H3 or greater
70	0.7798946	0.7625082	H3 or greater
75	0.7691195	0.7134283	H3 or greater
80	0.7457346	0.6492366	H3 or greater
85	0.7085323	0.5615052	H3 or greater
90	0.6446722	0.3979701	H3 or greater
95	0.5554444	0.2232398	H3 or greater
100	0.45483	0.1055076	H2
105	0.3394781	0.1216911	H2
110	0.2575784	0.177759	H1
115	0.208996	0.2024565	H1
120	0.1925521	0.1863364	H1
125	0.1862939	0.1761198	H1
130	0.18248	0.1662662	H1
135	0.1793789	0.1566458	H1
140	0.1764973	0.1473989	H1
145	0.1737335	0.13822	H1
150	0.1711232	0.1303559	H1
155	0.1686155	0.1237143	H1
160	0.1662042	0.1174297	H1
165	0.1638214	0.1116216	H1
170	0.1614792	0.1059385	H1
175	0.159322	0.1008634	H1
180	0.1571942	0.09632469	H1

1% AEP 120 minute			
Time H1 exceeded		75 minutes	
Time H2 exceeded		60 minutes	
Time	Depth (120m)	Velocity (120m)	Hazard Category
0	0	0	H1
5	3.33333E-08	0	H1
10	3.00333E-05	0	H1
15	0.02148671	0.08890267	H1
20	0.04170371	0.012267	H1
25	0.07952978	0.03078685	H1
30	0.1200681	0.0394689	H1
35	0.1506392	0.07920375	H1
40	0.2149659	0.1591284	H1
45	0.3888694	0.4714904	H2
50	0.5409656	0.6438704	H3 or greater
55	0.6469555	0.7488995	H3 or greater
60	0.7037343	0.7589924	H3 or greater
65	0.739655	0.7617067	H3 or greater
70	0.770847	0.7951857	H3 or greater
75	0.7846777	0.7875058	H3 or greater
80	0.7830778	0.7565746	H3 or greater
85	0.7700437	0.7023792	H3 or greater
90	0.7457028	0.647248	H3 or greater
95	0.7087268	0.5593641	H3 or greater
100	0.6448452	0.3999829	H3 or greater
105	0.5598406	0.2329754	H3 or greater
110	0.4678154	0.1242443	H2
115	0.3661035	0.101236	H2
120	0.2848607	0.1513715	H1
125	0.2327584	0.1998214	H1
130	0.2042138	0.2017522	H1
135	0.1939054	0.1905217	H1
140	0.1885901	0.1808896	H1
145	0.1848218	0.1720123	H1

Hazard limits from AIDR Guideline 7-3			
	VD Limit	D limit	V limit
H1	0.3	0.3	2
H2	0.6	0.5	2

Location of Data Extraction

History station 22 in revised SOBEK model. Location shown below.
SOBEK model results indicated that this is the location at which road access if first lost in the west.

