

Department of Planning and Environment

# Flood Impact and Risk Assessment

Flood Risk Management Guide LU01





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# Contents

1.	Introduction	1
1.1	Aim of a flood impact and risk assessment	1
1.2	Purpose of this guide	1
1.3	Who should use this guide?	2
1.4	What qualifications are needed?	2
1.5	How to use this guide	2
2.	Need for and scope of a flood impact and risk assessment	4
2.1	Need for a flood impact and risk assessment	4
2.2	Scope of a flood impact and risk assessment	4
2.3	General considerations in a flood impact and risk assessment	4
2.4	Guidelines and reference documents	5
2.5	Category of flood impact and risk assessment	8
2.6	Flood impact and risk assessment based on existing assessment requirements	8
2.7	Simple flood impact and risk assessment	8
2.8	Detailed flood impact and risk assessment	9
3.	Undertaking a flood impact and risk assessment	11
3.1	Proposed development	11
3.2	Existing and post development modelling and analysis	11
3.3	Impacts to be addressed	13
3.4	Managing flood risks	14
4.	Flood impact and risk assessment reporting	16
5.	Considerations for approval	17
6.	References	18
	Appendix A – Analysis, reporting and handover requirements	19

## List of tables

Table 1	Guidelines and reference documents	6
Table 2	Typical sources of information	7
Table 3	Typical considerations when assessing impacts due to development	13
Table 4	Typical measures to minimise impacts due to development	15
Table 5	Typical simple and detailed assessment scopes of work and information requirements for FIRA	19
Table 6	Typical outputs to be included in the FIRA report to support the proposal	25

## List of figures

Figure 1	Key steps for undertaking a flood impact and risk assessment	3
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# 1. Introduction

New development, or substantially modifying existing development, without effective consideration of the impacts of flooding can:

- change flood behaviour and have adverse impacts on the flood risk to the existing community and development
- place the development and its users at an unacceptable level of flood risk
- affect flood emergency response with adverse impacts on the ability of the existing community to respond to floods.

This can lead to increased flood risk due to adverse impacts of the development on the existing community and/or adverse impacts of flooding on the development and its users. These impacts can be limited by appropriate selection of location, development type and flood-related development controls in consideration of the flood constraints at the location.

Often these impacts are localised and can be readily managed; however, in the case of large developments, such as planning proposals relating to multi-lot subdivisions, or development that covers a significant area of the floodplain or developments in highly flood constrained areas (such as floodway areas), the impacts require further consideration to ensure they can be managed.

A fit for purpose flood impact and risk assessment (FIRA) can examine flood constraints and how to manage the flood risks posed to and by new development.

## 1.1 Aim of a flood impact and risk assessment

The aim of a FIRA is to support a development proposal to identify and analyse:

- the impacts of the proposed development on the flood risk to the existing community
- the impacts and risks of flooding on the development and its users
- how these impacts can be managed to minimise the growth in risk to the community due to the development.

A FIRA may also be required to provide information and define flood behaviour and constraints where there are gaps in available information.

A FIRA is different from a flood study undertaken in accordance with the Flood Risk Management (FRM) Manual (the manual) (DPE EES 2022b). Studies under the manual provide councils with information on the flood risk to their community, typically on a catchment scale. They provide advice on how to manage risk to the existing community, and flood information can be considered in decision-making, including planning instruments.

## 1.2 Purpose of this guide

This guide provides advice on the scope and scale of a FIRA. It does not replace the processes or requirements of the consent authority. It should be read in conjunction with and address any other assessment requirements for the development proposal/application. For example, for state significant development proposals being considered by the NSW Government, this guide should be read in conjunction with the Planning Secretary's Environmental Assessment Requirements (SEARs) issued for the development. It should also consider the requirements of any referral agencies.

## 1.3 Who should use this guide?

For development applications/planning proposals that need to consider flooding, the advice provided in this guide may assist:

- consent authorities or referral agencies to clearly identify the process and requirements for a FIRA for a development proposal/application
- those specifying studies for engagement of consultants
- those undertaking FIRA assessments to better understand these requirements.

## 1.4 What qualifications are needed?

Those scoping, undertaking and reviewing a FIRA should typically include an appropriately qualified professional engineer. They should have experience and advanced skills in catchment hydrology, floodplain hydraulics and have a good working knowledge of FRM practices and guidance in New South Wales. The qualifications needed to undertake a FIRA may depend on the assessment requirements for the development proposal.

## 1.5 How to use this guide

This guide identifies typical modelling and assessment considerations and processes to identify, assess and manage potential flood risks due to a development proposal.

Figure 1 provides an example FIRA process which considers different assessment pathways. It also outlines possible flood related interaction between the proponent and consent authority. The consent authority may have a different process or may modify this process to meet their needs depending on a range of factors, including the availability of existing information and requirements or scope and scale of FIRA necessary to determine the application.

The remainder of the guide generally follows the example process in Figure 1. It describes and expands the steps and typical considerations in scoping a FIRA. It is structured as follows:

- Section 2 covers the need for and scope of a FIRA. It outlines the considerations for the consent authority in requesting a FIRA, including advice on guidance and consideration of the scope and assessment method required and the different assessment pathways
- Section 3 is about preparing a FIRA, outlining considerations for doing the assessment, including understanding flood behaviour, its potential impacts and risks
- Section 4 outlines the typical requirements for documentation and reporting of a FIRA, with more detail provided in Appendix A
- Section 5 discusses assessment of a FIRA, including considerations for approval based on the assessment findings
- Section 6 provides the references cited in this guide.

Flood Impact and Risk Assessment

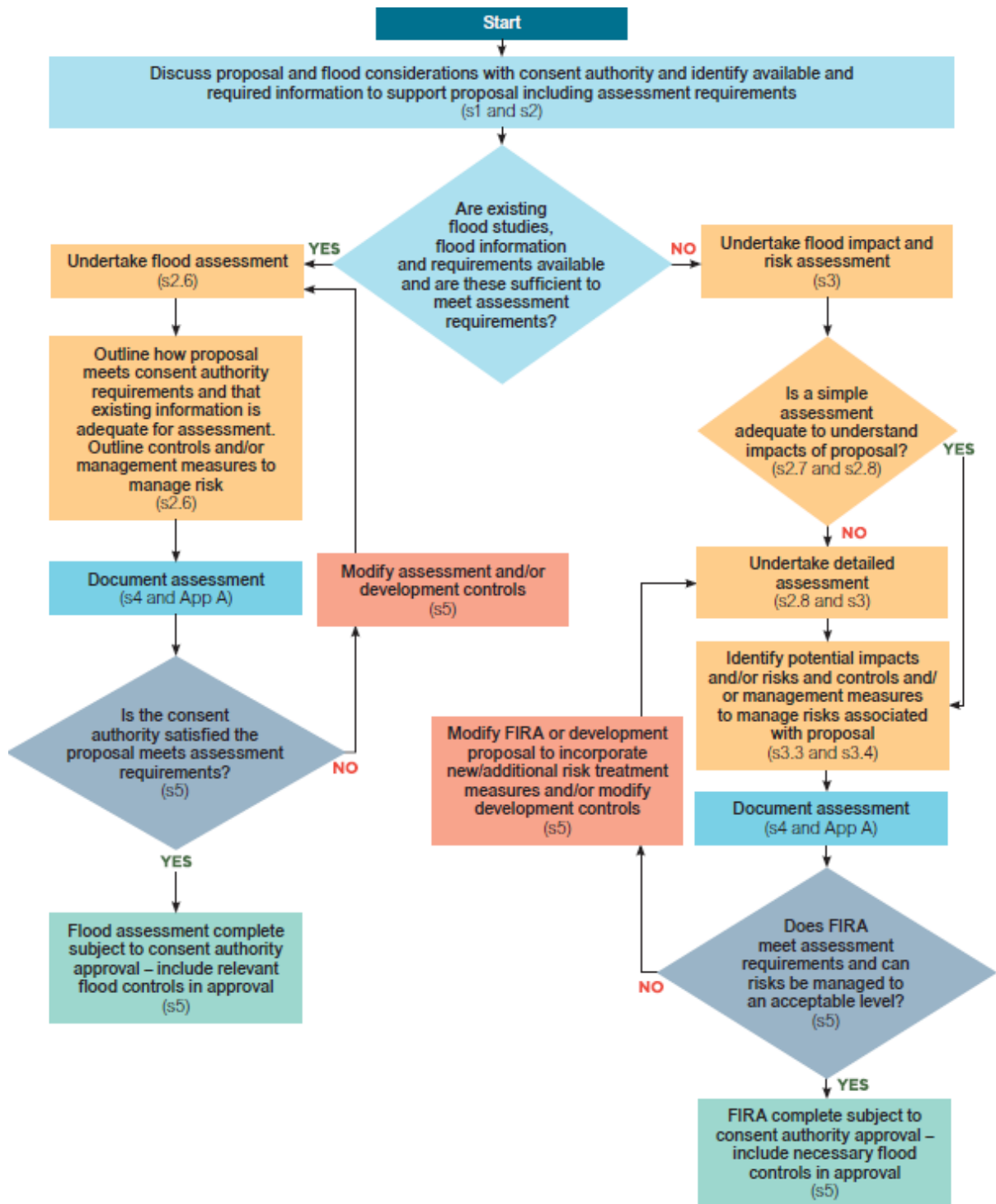


Figure 1 Key steps for undertaking a flood impact and risk assessment

## **2. Need for and scope of a flood impact and risk assessment**

### **2.1 Need for a flood impact and risk assessment**

A consent authority may require a FIRA to support an application under Part 4 Development Assessment and Consent of the *Environmental Planning and Assessment Act 1979* (EP&A Act). A FIRA may also be undertaken to support an activity under Part 5 of the EP&A Act where the activity is affected by flooding. A FIRA is also likely to be required where it is anticipated a proposed development could change flood behaviour, affect flood risk to the existing community or expose its users to flood risks that require management.

Each consent authority (utilising the expertise of referral agencies where necessary) is responsible for outlining the requirements for the FIRA, including the scope and reporting. Consent authorities have their own processes and requirements for assessing proposed development that may be impacted by flooding. These requirements may vary with the understanding and management of flood risk in their area in question.

### **2.2 Scope of a flood impact and risk assessment**

The scope of a FIRA to support an application for a development may vary depending on a number of factors including:

- the scale, type and location of the proposed development and whether it is consistent with existing planning instruments
- whether FRM studies have been undertaken at a suitable scale and used to set development requirements (including the potential for further work to be undertaken to support an application). These are often referred to in a council flood policy or development control plan (DCP)
- whether studies are not available, do not contain the information required to support the application, or do not cover the study area in sufficient detail to provide an understanding of flooding and the likely impacts due to development.

The proponent, possibly with the assistance of a specialist consultant, may discuss the scope of a FIRA with the consent authority during pre-lodgement or in preparation of the application. Addressing sections 1 to 4 as outlined in Table 5 provides the opportunity for the proponent to gather available information and knowledge of existing flood behaviour in the vicinity of the site. This knowledge can be used to clarify the scale of assessment and reporting needed to meet the requirements with the consent authority and referral agencies.

### **2.3 General considerations in a flood impact and risk assessment**

Having determined the need for a FIRA (Section 2.1) to address the aims discussed in Section 1.1, the next step is to scope the assessment. This should consider the:

- general requirements of assessment discussed below
- guidance and reference documents outlined in Section 2.4
- category of assessment and the scale of the FIRA required to support a development proposal, as discussed in Sections 2.5 to 2.8.



All assessments need to demonstrate compatibility of the development with any existing relevant State Environmental Planning Policies (SEPPs), local environmental plans (LEPs), DCPs or policies, as well as existing industry guidance, government guidance and reference documents outlined in Section 2.4.

In many cases, DCPs or flood policies may outline criteria for assessment for different types of developments. These requirements may be described either in a generic or local context depending on the availability of flood information (including that in council flood studies and FRM studies and plans).

In some situations, such as designated or state significant development on flood affected land, a FIRA would typically be required to meet the SEARs. In these situations, the scope and scale of the FIRA is also likely to vary depending on factors such as the likely impacts of the development on flooding, the vulnerability of the development and occupants to flooding or any potential impacts to the community.

For most developments a minimum level of information is required to ensure local flood constraints (see Table 3) can be effectively considered. In addition, for a FIRA to meet the aims outlined in Section 1.1 it requires an understanding of:

- the full range of flood risk. To achieve this, flood behaviour would be examined for a range of events. Typical events examined may include the 10%, 5%, 1%, 0.5% or 0.2% AEP and probable maximum flood (PMF)
- the potential for coincidence with downstream tailwater levels or ocean inundation levels where the area is influenced by backwater flooding from downstream waterways or the ocean
- the constraints that flood places on the land (floodways, flood storage, flood hazard and emergency response issues) determined for a number of events, typically 5%, 1%, 0.2% or 0.5% AEP and PMF
- the appropriateness of the development or development types for the location based on the flood constraints on the land
- the adequacy of management measures and controls to:
  - effectively address these constraints to ensure the flood risks to the proposed development and its users are acceptable
  - manage flood and associated emergency management (EM) impacts to the existing community due to the development
- the choice of Australian Rainfall and Runoff (ARR) version to use. This is discussed in Section 2.4.1
- climate change impacts. Both existing and post development flood behaviour needs to consider climate change impacts on flood behaviour so the robustness of decisions over time can be understood. This is discussed in Section 2.4.2.

## **2.4 Guidelines and reference documents**

FIRA investigations should be undertaken in consideration of relevant guidance, standards and requirements for flood modelling and analysis and the available information. These may be outlined in documents including but not limited to:

- development assessment requirements; for example, for state significant development or state significant infrastructure, the SEARs
- planning instruments such as SEPPs, LEPs as well as non-statutory documents such as DCPs and local policies

- relevant local council standards, such as flood policies or subdivision guidelines or advice on consideration of climate change impacts on sea level rise or flood producing rainfall events
- flood studies and FRM studies and plans relevant to the local area. These studies are generally undertaken for councils through the FRM process outlined in the manual
- current industry guidelines, manuals and technical reference documents such as ARR and associated NSW-specific guidance. This guide does not provide advice on hydrologic or hydraulic assessment techniques, including choice of model, parameters to use or understanding FRM in New South Wales. Relevant industry and government guidance should be referred to for this purpose. Reference to some of this guidance is included in Table 1
- NSW guidance, including but not limited to those referred to in this guide and Table 1.

**Table 1 Guidelines and reference documents**

Reference	Source/link	Topic	Comment
<b>New South Wales</b>			
NSW Government's <i>Flood Risk Management Manual: The management of flood liable land</i> , 2022, incorporating the NSW Flood Prone Land Policy (DPE EES 2022a&b)		Flood prone land policy and industry practice	Consider
<b>Flood risk management guidelines</b>			
FRM Guide AG01 and the current versions of relevant guides outlined in that guide			
NSW Flood Data Portal	<a href="http://floodata.ses.nsw.gov.au/">floodata.ses.nsw.gov.au/</a>	Flood data	Consider
<b>National</b>			
Australian Institute of Disaster Resilience (AIDR) Handbook Series, <i>Managing the floodplain: A guide to best practice in flood risk management in Australia – AIDR Handbook 7</i> (AIDR 2017)	<a href="http://knowledge.aidr.org.au/resources/handbook-managing-the-floodplain/">knowledge.aidr.org.au/resources/handbook-managing-the-floodplain/</a>	Best practice	Consider
Australian Rainfall & Runoff (ARR; this includes ARR2019 and specific project reports, such as Project 15 – Two-dimensional modelling in urban and rural floodplains)	<a href="http://arr.ga.gov.au/">arr.ga.gov.au/</a> <a href="http://arr.ga.gov.au/arr-guideline/revision-projects/project-list">arr.ga.gov.au/arr-guideline/revision-projects/project-list</a>	Best practice	Consider
Australian Building Codes Board (ABCB) <i>Construction of Buildings in Flood Hazard Areas</i>	<a href="http://www.abcb.gov.au/Resources/Publications/Education-Training/Construction-of-Buildings-in-Flood-Hazard-Areas-Standard">www.abcb.gov.au/Resources/Publications/Education-Training/Construction-of-Buildings-in-Flood-Hazard-Areas-Standard</a>	Structural soundness	Consider

Flood information may be available from more than one source. Councils are often the primary source of flood information given their role in managing flood risk for their communities. They need to be consulted when development is proposed on flood prone land within their community given the potential impacts on flooding and their role in the management of flood risk. Some typical sources of information are provided in Table 2.

Guidance should be considered in FIRAs in a fit for purpose way to analyse the flood constraints for the development being considered.

**Table 2 Typical sources of information**

Source of information	Description
Consent authority and referral agencies	May be able to identify data sources and studies or plans relevant to the location
Local councils	May be able to identify data sources and studies or have had studies undertaken or plans that are relevant to the location. They may also have relevant historical information and knowledge of changes that have occurred since studies were undertaken that may impact flood behaviour
Relevant state agencies, including the lead FRM agency and flood combat and flood EM agency as outlined in FRM Guide AG01	Likely to require discussions with relevant staff in these organisations and may involve the need to access information from databases
Bureau of Meteorology (BoM) and relevant water level gauging network and dam operators	Likely to require discussions with relevant staff in these organisations and may involve the need to access information from databases
NSW Flood Data Portal	Can provide a valuable reference to inform an initial desktop review of available studies for an area. Note that only a limited number of studies are available through the portal. Any reliance on available studies should be confirmed with council and other relevant sources such as those identified above

### 2.4.1 Choice of Australian Rainfall and Runoff version

Where existing council or government studies or previous site investigations or development requirement of councils are based on a particular release of ARR, the consent authority may recommend the continuation of this approach in the FIRA. This approach ensures the impacts assessed, and the controls used, are consistent with council studies and practices and flood behaviour derived from models that were calibrated and validated against historic floods. The proponent should confirm with the consent authority which release of ARR and the associated methods are to be used in the FIRA.

### 2.4.2 Considering climate change

For developments with a life exceeding 20 years the implications of climate change should be assessed considering the requirements of the consent authority. This may include consideration of:

- sea level rise where the waterway in the vicinity of the study area is within the tidal limits
- increased intensity of flood producing rainfall events. Modelling could assess sensitivity of flood behaviour to changes by using either the 0.5% and/or 0.2% AEP event as an indicator of sensitivity to change in the 1% AEP flood event.

## 2.5 Category of flood impact and risk assessment

The category of FIRA undertaken to support an application for a development proposal will depend on whether there is existing information and development requirements for an area or whether further analysis is required. Situations where, for example, proposals for small-scale filling in flood fringe areas (outside of floodway and flood storage areas) may not significantly impact flood behaviour or risk must also be considered. However, other proposals, say for filling or development in floodway or flood storage areas, are likely to need more analysis to understand their potential impacts on flood behaviour and risks to others.

Flood impact and risk assessments typically fall into one of three categories of assessment that are considered in this guide:

- FIRA based on existing flood requirements such as those specified in a council LEP and DCP – discussed in Section 2.6
- simple FIRA – discussed in Section 2.7
- detailed FIRA – discussed in Section 2.8.

The scope of the assessments within these different categories needs to consider the advice provided in earlier parts of Section 2.

## 2.6 Flood impact and risk assessment based on existing assessment requirements

Where existing assessment requirements for the development site are available, such as those identified in an existing LEP and DCP, the assessment should consider these requirements and relevant information or recommendations contained in local flood studies or FRM studies or plans. Council's DCP, policies or other requirements may outline objectives, any performance criteria and/or requirements relating to flooding for this location. They will also often outline the required flood assessment methodology and the information to be submitted to support an application. Where the existing assessment requirements are considered suitable, it is recommended the scope of the FIRA is negotiated with the consent authority to determine a scope that is fit for purpose.

These assessments will typically require consideration of the development type and flood related constraints on land in the proposed location to determine relevant assessment and management measures required to manage the impacts of and on the development.

## 2.7 Simple flood impact and risk assessment

A FIRA based on a simple assessment should consider the requirements of the local council (see Section 2.6) or relevant consent authority. A simple assessment may be used:

- where no flood information or assessment requirements exist and the proposed development is relatively small-scale, such as single lot residential dwelling and associated works
- for a preliminary or initial stage assessment of impacts in larger developments to assist in scoping a more detailed assessment. This is particularly useful where the flood behaviour and the degree of potential impact on the development site is not known.

Simple assessments typically utilise simple techniques or modelling to establish an understanding of existing flood behaviour and assess the impacts of the proposed development on flooding and the existing community. They may include a check for key flood characteristics, including conveyance, hazard, flood storage and flood levels at a location based on a series of floods. This may be done by cross-sectional analysis utilising



representative pre and post development cross-sections, and existing flow information or flows determined utilising suitable techniques outlined in the current version of ARR. It should also consider the potential for changes in flow as part of the development.

The results of the analysis can:

- provide the information required to inform controls for the development proportionate with flood behaviour and the associated risks
- provide information on key flood characteristics at critical locations
- identify the potential for any significant adverse impacts to the existing community and development as a result of the proposed development. Where impacts are expected to be significant, a more detailed assessment would generally be warranted.

Where compatibility with relevant industry guidance or assessment criteria cannot be demonstrated, the development may need reconsideration, or a more detailed assessment may be required to examine management options.

## 2.8 Detailed flood impact and risk assessment

A detailed FIRA needs to be fit for purpose, and consider the relevant guidelines, reference documents and sources of information (such as identified in Table 1 and Flood information may be available from more than one source. Councils are often the primary source of flood information given their role in managing flood risk for their communities. They need to be consulted when development is proposed on flood prone land within their community given the potential impacts on flooding and their role in the management of flood risk. Some typical sources of information are provided in Table 2.

Guidance should be considered in FIRAs in a fit for purpose way to analyse the flood constraints for the development being considered (Table 2). These include council DCPs and policies and relevant local flood information.

A detailed FIRA needs to be scoped and undertaken by suitably qualified and experienced professionals (see Section 1.4). A detailed FIRA would typically be required when:

- no flood information for the proposed site exists in an existing study or plan and the proposed development is of a large scale or involves rezoning
- there are known deficiencies in broad-scale flood modelling
- the proposed development is of significant scale that would likely impact catchment hydrology and/or flood behaviour
- a simple assessment shows a potentially significant impact on flood behaviour or to the development
- a proposed development will significantly increase the population on flood prone land or will significantly impact flood evacuation of the existing community.

Detailed assessments typically utilise complex techniques or modelling to establish an understanding of existing flood behaviour and assess the impacts of the proposed development on flooding and the existing community.

This would include analyses of key flood characteristics, including conveyance, hazard, flood storage and flood levels based on a series of floods, for pre and post development conditions, using suitable techniques outlined in the specified version of ARR.

The results of the analysis can:

- provide the information required to inform controls for the development proportionate with flood behaviour and the associated risks
- provide information on key flood characteristics at critical locations

- identify the potential for any significant adverse impacts to the existing community and development as a result of the proposed development. Where impacts are expected to be significant, further assessment and in some cases additional modelling or analysis may be warranted.

Where compatibility with relevant industry guidance or assessment criteria cannot be demonstrated, the development may need reconsideration, or a more detailed assessment may be required that can examine management options.

### 3. Undertaking a flood impact and risk assessment

In undertaking the FIRA several aspects need to be considered, modelled, analysed and reported.

Whilst the type and scale of assessment for the FIRA can vary, generally the assessment will need to provide details to the consent authority on the:

- proposed development, see Section 3.1
- existing and developed cases, see Section 3.2
- impacts and the capacity of the development to manage impacts, see Sections 3.3 and 3.4
- the residual risk as discussed in Section 3.4.

Flood impact and risk assessment reporting is discussed in Section 4 and with typical analysis, reporting and handover requirements outlined in Appendix A. This includes a summary table of contents (Table 5) and supporting information including summary advice on scopes of work and information requirements for a FIRA as well as associated outputs (Table 6).

#### 3.1 Proposed development

The proposed development needs to be shown with the necessary detail to support the application and provide an understanding of the potential impacts of the development on flood behaviour and the potential impacts of flooding on the development. Consent authorities typically have application checklists or similar that can be referred to and may assist.

#### 3.2 Existing and post development modelling and analysis

The techniques used for modelling need to be fit for purpose considering the location, the type and scale of development, and the potential for it to affect flood behaviour in surrounding properties.

The consent authority will need to ensure that flood modelling and/or analysis is sufficient to identify and assess the existing flood conditions and to determine post developed flood impacts and risks. Assessment needs to consider the key details of the final proposal, including development type and density (changing runoff characteristics), infrastructure, proposed modification to waterways or floodplain landform or vegetation.

Where developments are to be staged, consideration also needs to be given to management of changes in flood behaviour during staging; for example, where a flood detention basin is required to offset the overall impacts of development this may need to be constructed in an early stage of the development to address adverse impacts of the early stages of development.

The FIRA report is to identify all impacts, management measures and the methodology used to identify changes in flood behaviour due to development that are relevant to their assessment.

Sections 3.3 and 3.4 provide advice on how flood impacts and risks may be considered as part of the assessment, considering the full range of flooding. This aims to ensure the

impacts to existing development are understood and the risks posed due to development have been considered and found acceptable for both the existing and future community.

The analysis needs to be adequately documented and is to include relevant advice outlined in Table 5, mapping identified in Table 6, and the following:

- the flood models used (where applicable), updated or produced for the conditions with the proposed development, ensuring any changes or new models produced are documented
- details of any management measures to be implemented to minimise the impacts and risks posed to the existing and future community due to development. This should include advice on when management measures are required in staged developments
- an assessment of the residual impacts of the project (that management measures cannot manage) on and off the site
- the recommendations should be documented in the report.

Section 2 outlines the level of assessment required for the FIRA, some of the key guidelines and references, and some considerations for flood modelling and analysis to use in identifying existing flood conditions, including consideration of ARR and climate change as part of a FIRA.

### 3.2.1 Existing flood behaviour

Understanding the flood behaviour for the full range of events (as discussed in Section 2) and the current flood constraints on the subject site and in areas surrounding the site, is critical in understanding the potential flood impacts of the development.

In some cases, studies may have been completed that adequately describe the existing flood behaviour and have developed information on flood constraints to consider in land-use planning decisions (see FRM Guide FB01). Where available, this information can inform the assessment. If an existing model is going to be used for the FIRA, it should be examined to ensure it is fit for purpose (i.e. at a resolution appropriate for analysing the development and its surrounds) and updated if required. If updates are required, the model should be calibrated and validated to ensure it is producing reasonable results consistent with the original study and current techniques.

In other cases, modelling will be required to establish and document a base case of existing flood behaviour and constraints on which the impacts of development can be assessed. In this case, the model and assessment will need to consider all relevant sources of flooding within, or which may impact, the floodplain and the key flood constraints (see FRM Guide FB01) on and surrounding the site and consistent with the council DCP. The existing base case should also consider both the existing climatic conditions and where relevant future climatic conditions (see Section 2.4.2).

### 3.2.2 Post development flood behaviour

Developments can and will often influence flood behaviour. This can be due to the project altering the landform or undertaking works such as filling, waterway crossings, modifications to waterways or flowpaths and vegetation changes, adding structures that affect flood behaviour, as well as changes to catchment imperviousness leading to incremental changes in flood hydrology.

The impacts associated with these changes may:

- be contained where possible within the development site
- result in relatively minor impacts beyond the development site (often due to the scale of the development)



- have detrimental impacts that affect other land or the community more broadly and require more careful assessment and management.

Analysis of post developed flood behaviour requires consideration of the proposed development and the use of fit for purpose tools that can adequately represent any changes in flood behaviour. It should be undertaken consistent with the analysis of scenarios for the base case, that is, for both the current climatic conditions and the same future climatic conditions.

Results need to be carefully analysed and compared to the base case of pre-developed flood behaviour and characteristics (as shown in Table 3) and should include consideration of changes to these over a range of key design events and at key locations. Comparison should consider differences between both the existing and future climatic conditions.

The FIRA should clearly document any changes in flood behaviour and characteristics. Understanding the impacts and risks associated with these changes is described in Sections 3.3 and 3.4.

Where the impacts external to the development site are considered significant, this may require additional modelling and reporting on modification to the development and consideration of management measures to minimise flood impacts. This is further described in Sections 3.4 and 4.

### 3.3 Impacts to be addressed

Post development flood impacts need to be tested and considered based on the requirements of the consent authority, referral agency and/or council.

These will typically cover the need to address impacts based on the changes in flood behaviour to the existing development and the community with both existing and future climatic conditions and across the range of events examined. The impacts and their typical considerations are identified in Table 3.

**Table 3 Typical considerations when assessing impacts due to development**

Key considerations	Reasons for considering
Flood level change	<ul style="list-style-type: none"> <li>• May increase inundation and damage to existing development</li> <li>• May inundate additional existing development</li> <li>• May create new or larger floodways or flowpaths</li> <li>• May isolate new areas</li> </ul>
Change in duration of flooding	<ul style="list-style-type: none"> <li>• May increase damage</li> <li>• May increase duration of isolation</li> </ul>
Velocity change	<ul style="list-style-type: none"> <li>• May increase scour potential and/or damage to buildings</li> </ul>
Change in warning and evacuation time	<ul style="list-style-type: none"> <li>• May decrease available warning time and time available for evacuation</li> </ul>
Change in frequency of inundation	<ul style="list-style-type: none"> <li>• Properties may become flood affected in more frequent events</li> <li>• Access may be cut more frequently</li> <li>• Areas may be isolated more frequently</li> </ul>
Flood function categorisation change	<ul style="list-style-type: none"> <li>• May change categorisation (e.g. flood storage to floodway) and change impacts on flooding on existing development</li> </ul>
Hazard categorisation change	<ul style="list-style-type: none"> <li>• May reduce safety to vehicles, people or buildings</li> </ul>

The full range of flood events needs to be considered as issues will differ with flood frequency; for example, while the impacts of development on peak flood levels may be acceptable for the 1% AEP flood event, the impact the development may have on the rate of rise of an extreme flood event may be unacceptable due to the inability of the community to evacuate via a designated evacuation route.

There is also the potential for the development to impact adversely on the existing community by altering the frequency of flooding or the behaviour of more frequent floods than the 1% AEP. These changes could potentially cause increased or more frequent inundation, damage or disruption of the community.

In some situations where adequate flood information exists, and the likely impacts associated with the development can be identified, a qualitative assessment or simple analysis may be sufficient to assess the potential impacts.

Simple assessments require significant judgement by an experienced and suitably qualified flood risk manager practitioner (see Section 1.4) to ensure the assessment is fit for purpose and the proposed development does not cause unacceptable flood impacts on and off the site.

Assessment for large-scale developments intended to create or significantly grow communities should assess the varying flood constraints (see FRM Guide FB01) for the site consistent with the approach included in council's DCP or required by council. These can be used with an understanding of the vulnerability of different land uses and their users to flooding (see FRM Guide FB01) to inform decisions on how to develop the area considering flooding (identifying what areas are suitable for different types of development). This can inform the development of associated planning instruments for a development site such as a SEPP or LEP and ultimately the DCP.

### **3.4 Managing flood risks**

The impacts of flooding discussed above provide key information for understanding the risk to the existing community, the development and its users, and the supporting infrastructure. These risks can then be considered in a strategic context to either alter the design of the development and/or to determine appropriate management measures to minimise flood risks resulting from the development.

In many situations there will be opportunities to limit the increase in risk due to development; however, available options will vary depending on the stage and scale of the development being considered. Typical risk considerations include the risks to people, property and infrastructure, including the ability of the occupants to respond in an emergency. Residual risks will remain after management measures and development controls have been applied. This may include situations where the flood range between the defined flood event (DFE) and the PMF is greater than the freeboard, for example. Freeboard is applied to the DFE to get the flood planning level (FPL) used to define minimum habitable floor levels for structures. In these situations, consideration needs to be given to the residual risks to people and the development itself.

Table 4 outlines some of the measures available to assist in minimising the increase in flood risk through management measures and development controls to large and small-scale development.

Residual risks will remain after management measures and development controls have been applied. This may include situations where the flood range between the defined flood event (DFE) and the PMF is greater than the freeboard, for example. Freeboard is applied to the DFE to get the flood planning level (FPL) used to define minimum habitable floor levels for structures. In these situations, consideration needs to be given to the residual risks to people and the development itself.

**Table 4 Typical measures to minimise impacts due to development**

Multi-lot, large-scale development	Individual, small-scale development
<p>Include strategic management considerations and measures:</p> <ul style="list-style-type: none"> <li>• avoid floodways and flowpaths</li> <li>• avoid other highly flood constrained areas</li> <li>• provide management measures to manage risks to existing development</li> <li>• consider compatibility of land uses/ development types with the flood constraints on the land</li> <li>• determine and apply controls required to manage risk to the development and its users</li> <li>• consider emergency response issues and options and provide management measures consistent with advice from emergency services</li> </ul>	<p>Generally:</p> <ul style="list-style-type: none"> <li>• avoid floodways and flowpaths</li> <li>• avoid other highly flood constrained areas</li> <li>• apply controls to manage the risk to the development and its users: <ul style="list-style-type: none"> <li>• management and design measures</li> <li>• structural considerations</li> <li>• floor level controls</li> </ul> </li> </ul>

The consent authority and/or local council (generally through a DCP) will often have advice in relation to typical considerations and standards required by different types of development, depending on the flood constraints in the area. Where this isn't the case, consideration should be given to whether the development proposed is compatible with flood behaviour and constraints and the management of the associated risks. For example, where the users of a development are relatively vulnerable in emergency response, locating the development in an area where self-evacuation is relatively straightforward and can be readily completed within the available timeframes can limit the risk. FRM Guide FB01 provides advice on the relative vulnerability of different types of development and their users to flooding.

Any assumptions relating to identification of and acceptability of risk will need to be clearly documented and considered in the context of the consent authority's adopted risk management approach.

## 4. Flood impact and risk assessment reporting

A key component of the FIRA is documenting the process and analysis undertaken to determine the impacts and risks due to flooding and how these are to be effectively managed. This includes providing an adequate description of the development, study background, consent authority's requirements, existing information, analysis including modelling methodology (where required) for the existing case, impacts associated with the final post developed case (including any management measures) and the requirements for the development.

Reporting and analysis requirements will vary depending on a range of factors including the scale of assessment required by the consent authority and the available information. Where this guide is applied it can be assumed that the FIRA assessment as outlined in this guide applies unless an alternative or reduced assessment method has been agreed by the consent authority.

Table 5 describes both a typical table of contents for reporting as well as a summary of the key considerations relating to reporting on the FIRA. This table has been developed in line with a simple or detailed assessment (see Section 2) and should be modified to suit the requirements of the consent authority in relation to the scale of assessment to be done to support the development proposal, to ensure it is fit for purpose. In some instances (i.e. where flood information exists and the assessment is likely to be straight forward) it may be appropriate for the FIRA to be a short letter report or be part of the overall application to support the proposal.

The consent authority should also ensure the handover of data associated with background information, analysis, modelling and figures used for reporting. Table 6 describes the key information typically required to be handed over and common formats of required handover data. This should also be modified to suit the scale of assessment as appropriate.



## 5. Considerations for approval

As part of the development approval process, the consent authority needs to ensure the assessment is adequate. This includes ensuring that risks to the development and its users and any offsite impacts on the existing community have been managed in accordance with the requirements agreed with the consent authority. A FIRA report, including advice on development details, model description (where applicable), impacts and risks, management measures, planning instruments and DCP considerations, and conditions necessary to manage risks to acceptable levels, should form part of the approved proposal.

Where an assessment requires further consideration, either due to deficiencies with aspects such as modelling, analysis, assumptions or management measures, the consent authority may require further analysis. This would generally be required prior to approval being granted to ensure the risks created by the proposal can be managed to an acceptable level.

Documentation should ensure the intent of the approval is clear and maintained for the life of the approved development. This may include the need for conditions that consider:

- limiting impacts and risks posed to the development and future occupants to ensure these have been appropriately managed. Consent conditions are to incorporate the key requirements to ensure these aspects are addressed. This may include the need to apply flood related controls such as those that nominate minimum fill or floor levels, structural considerations, management measures, address site egress, ensure the safety of occupants during flooding, and restrict unapproved modification to key elements of the development as approved in the consent through requiring restrictions on the use of land or similar in accordance with section 88b of the *Conveyancing Act 1919* as required, etc.
- management measures required to be considered in a staged manner as necessary to manage risks to the existing community
- inclusion of all design reports and drawings in the consent to ensure these are consistent with key parameters used in post development modelling and analysis that formed the basis of the FIRA
- modification of key design features of the development that may alter flood behaviour. This may require an additional approval with supporting modelling and/or reporting to ensure impacts of post developed flood risks are either in accordance with the original approval or are within the tolerable levels as defined by the consent authority
- how risks and impacts of the development change with future climatic conditions
- any other specific requirements for consideration by the proponent to manage flood risk.

## 6. References

Australian Institute for Disaster Resilience (AIDR) 2017, Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, Australian Institute for Disaster Resilience, East Melbourne.

Department of Infrastructure, Planning and Natural Resources (DIPNR) 2005, *Floodplain Development Manual: the management of flood liable land*, DIPNR 05\_020, NSW Department of Infrastructure Planning and Natural Resources, Sydney.

Department of Planning and Environment (Environment, Energy and Science Division), (DPE EES) 2022a, *NSW Flood Prone Land Policy*, NSW Department of Planning and Environment (Environment, Energy and Science Division), Sydney.

Department of Planning and Environment (Environment, Energy and Science Division), (DPE EES) 2022b, *NSW Flood Risk Management Manual: The management of flood liable land*, NSW Department of Planning and Environment (Environment, Energy and Science Division), Sydney.

Department of Planning and Environment (Environment, Energy and Science Division), (DPE EES) 2022c, *Flood Risk Management Guide: Administration Arrangements*, (AG01), NSW Department of Planning and Environment (Environment, Energy and Science Division), Sydney.

Department of Planning and Environment (Environment, Energy and Science Division), (DPE EES) 2022d, *Flood Risk Management Guide: Understanding and Managing Flood Risk*, (FB01), NSW Department of Planning and Environment (Environment, Energy and Science Division), Sydney.

## Appendix A – Analysis, reporting and handover requirements

**Table 5 Typical simple and detailed assessment scopes of work and information requirements for FIRA**

Table of contents		Key considerations and reporting requirements		Supporting information
		All assessments (where column is not split)		
Section	Subsection	Simple assessment	Detailed assessment	
Executive summary			Findings of the FIRA including: <ul style="list-style-type: none"> <li>• analysis undertaken</li> <li>• proposed development</li> <li>• key conclusions and recommendations</li> </ul>	
1. Introduction	1.1 Background	Background: <ul style="list-style-type: none"> <li>• purpose of the FIRA</li> <li>• client details</li> <li>• property address, size and description of location and details of proposed development</li> </ul>		<ul style="list-style-type: none"> <li>• Location map</li> <li>• Development plans (site, floor, elevations, cross-sections, survey plans)</li> </ul>
	1.2 Project context	Description of project context: <ul style="list-style-type: none"> <li>• any FIRAs or FRM studies or plans previously conducted and relevant to the site</li> <li>• history of the application</li> </ul>		
	1.3 FIRA requirements	Description of discussion with consent authority and requirements: <ul style="list-style-type: none"> <li>• any correspondence with the consent authority and referral agencies on FIRA requirements</li> <li>• general relevant assessment requirements (see Sections 2 and 3 of this guide)</li> </ul>		
2. Background	2.1 Study area	Description of the study area: <ul style="list-style-type: none"> <li>• catchments, topography, waterways, flood-dependent ecosystems, oceanic influences</li> <li>• land use and existing development</li> <li>• hydrologic/hydraulic controls</li> </ul>		<ul style="list-style-type: none"> <li>• Catchment map</li> <li>• Study area map showing key features including existing flood</li> </ul>

Table of contents		Key considerations and reporting requirements		Supporting information
		All assessments (where column is not split)		
Section	Subsection	Simple assessment	Detailed assessment	
	2.2 Known flood behaviour	Description of the flood behaviour: <ul style="list-style-type: none"> <li>• type</li> <li>• duration and how often inundated</li> <li>• existing flood problems</li> <li>• hydrologic/hydraulic controls' effect on flooding</li> <li>• coincident tributary flooding</li> <li>• other factors (e.g. blockage, high tides, antecedent conditions)</li> </ul>		extent information where available <ul style="list-style-type: none"> <li>• Known flood behaviour mapping</li> </ul>
	2.3 Flood history	Description of the flood history: <ul style="list-style-type: none"> <li>• recent and largest recorded events</li> <li>• area of inundation and impacts on the community</li> <li>• catchment description at historical event relative to present day for key events</li> </ul>		
	2.4 Emergency management	Outline existing EM strategy for the area	Description of the existing EM: <ul style="list-style-type: none"> <li>• response/preparation time</li> <li>• warning systems and time</li> <li>• local/regional EM strategies or plans</li> </ul>	
3. Available information		List and describe: <ul style="list-style-type: none"> <li>• previous studies and model files, including whether the information is fit for purpose for the assessment; if yes then it will need to be reproduced in the report including figures and detailed descriptions</li> <li>• relevant legislation, policy and guidance</li> <li>• flood EM plans (e.g. local flood plans)</li> <li>• historic data, including summary of key events and available data</li> <li>• hydrologic and hydraulic data, including stream flow records, rating curves, rainfall records, ocean and water level data and rainfall gauges</li> <li>• site visit, including any observations that may impact or be impacted by flood; photos and figures should be included where relevant</li> <li>• survey data, including existing or new survey data; for example, DEMs, LiDAR data, creek/river cross-sections or hydro surveys, location of drainage assets, floor levels and existing structures</li> </ul>		<ul style="list-style-type: none"> <li>• Refer to Sections 2 and 3 of this guide</li> <li>• Some current guidelines and references identified in Section 2.4 and Table 2</li> </ul>



Table of contents		Key considerations and reporting requirements		Supporting information
		All assessments (where column is not split)		
Section	Subsection	Simple assessment	Detailed assessment	
		<ul style="list-style-type: none"> <li>geographic information system (GIS) data, including cadastral layers, waterways, natural environment areas, street names, roads and land-use zoning</li> </ul>		
4. Flood related requirements		<p>Describe flood related requirements:</p> <ul style="list-style-type: none"> <li>requirements of the consent authority and referral agencies</li> <li>relevant legislation, policies and guides</li> <li>scale of assessment</li> <li>identify compatibility or deviation from existing FRM plans</li> </ul>		<ul style="list-style-type: none"> <li>Outline requirements to be met</li> <li>Outline proposed assessment method</li> <li>Refer to Sections 2.5 to 2.8 of this guide</li> <li>Some guidelines and references identified in Section 2.4 and Table 2</li> </ul>
5. Pre-developed modelling and analysis	5.1 Existing flood modelling	<p>Description of methodology and modelling as applicable including:</p> <ul style="list-style-type: none"> <li>design events assessed</li> <li>hydrologic and hydraulic controls and any changes over time, particularly since calibration, validation events or completion of existing studies</li> <li>flood modelling techniques and results</li> </ul>	<p>Description of methodology and modelling including:</p> <ul style="list-style-type: none"> <li>design events assessed</li> <li>hydrologic and hydraulic controls and any changes over time, particularly since calibration, validation events or completion of existing studies</li> <li>modelling approach used and how it was undertaken, why it is fit for purpose and how it meets with industry best practice and relevant local council requirements</li> <li>model review where applicable – fitness for purpose including currency, model parameters and identify recommended modifications or alternative approaches, model selection, version, setup, parameter selection, data inputs and sources including losses, pre-burst and design storms</li> </ul>	<ul style="list-style-type: none"> <li>Refer to Section 3.2 of this guide</li> <li>Map hydrologic and hydraulic model catchment layout, including any relevant cross-sections and structures</li> </ul>

Table of contents		Key considerations and reporting requirements		Supporting information
		All assessments (where column is not split)		
Section	Subsection	Simple assessment	Detailed assessment	
		<ul style="list-style-type: none"> <li>model checks as required</li> </ul>	<ul style="list-style-type: none"> <li>model calibration and validation relative to historic information and design event flows from relevant government studies including comparison between design results and calibration and validation data</li> <li>sensitivity to parameters, including testing on parameters than can impact modelling results</li> <li>model results, report on and present results for all design events</li> <li>model checks including how results have been checked in the model and verified independently</li> </ul>	
	5.2 Existing flood impacts	<p>Describe and document existing:</p> <ul style="list-style-type: none"> <li>flood behaviour for the full range of flooding at and surrounding the site</li> <li>flood impacts on surrounding properties</li> <li>any additional data</li> </ul>	<p>Describe and document:</p> <ul style="list-style-type: none"> <li>additional data collection – knowledge gained</li> <li>flood events – variation in frequency and inundation of the site across the full range of events</li> <li>evacuation routes and vulnerability to flooding, any limitations on evacuation and flood emergency response classification for the site and surrounding area (where already available)</li> <li>hydrologic and hydraulic controls affecting flooding</li> <li>existing flood constraints consistent with the council DCP (where required)</li> <li>climate change impacts</li> </ul>	<ul style="list-style-type: none"> <li>Refer to Section 3.2 of this guide</li> </ul>
6. Post developed modelling and analysis	6.1 Proposed development flood modelling/assessment	<p>Describe and document:</p> <ul style="list-style-type: none"> <li>analysis undertaken including modelling and modelling assumptions as required</li> <li>changes due to proposed development –</li> </ul>	<p>Describe and document:</p> <ul style="list-style-type: none"> <li>changes to existing models or new models and versions</li> <li>changes due to proposed development difference between existing and post development outputs at key locations</li> <li>alternatives to address development impacts outside acceptable limits</li> </ul>	<ul style="list-style-type: none"> <li>Refer to Section 3.2 to 3.4 of this guide</li> </ul>

Table of contents		Key considerations and reporting requirements		Supporting information
		All assessments (where column is not split)		
Section	Subsection	Simple assessment	Detailed assessment	
		<p>difference between existing and post development outputs at key locations</p>	<ul style="list-style-type: none"> <li>any alternative risk assessment approach and findings</li> <li>key modelling parameters, how these vary across the floodplain and change with development</li> <li>flood flows and volumes at key points</li> <li>flowpaths and flood constraints including floodways and flood hazard through the study area, flood emergency response classification of the community (where already available)</li> <li>frequency of flooding and flood levels of key events</li> <li>climate change impacts</li> </ul>	
	6.2 Flood impacts of proposed development	<p>Describe and document changes due to proposed development in:</p> <ul style="list-style-type: none"> <li>impacts of flood behaviour</li> <li>changes to frequency/scale of inundation of existing properties where known</li> <li>the impacts on the proposed development and users</li> </ul>	<p>Describe and document changes due to proposed development in:</p> <ul style="list-style-type: none"> <li>impacts of flood behaviour and constraints on existing development surrounding the development site including flood evacuation of the existing community</li> <li>changes to frequency/scale of inundation of existing properties where known</li> <li>the impacts on the proposed development and users including ability of community to effectively evacuate</li> </ul>	<ul style="list-style-type: none"> <li>Refer to Sections 3.2 and 3.3 of this guide regarding impacts of proposed development on flooding</li> </ul>
7. Key risks to be managed		<p>Describe and document:</p> <ul style="list-style-type: none"> <li>proposed management measures or alterations to the development required to address impacts to the development and its users and any offsite impacts</li> <li>comparison of pre and post management measure impacts considering management measures with development requirements from consent authority and how they meet any flood related objectives</li> </ul>		<ul style="list-style-type: none"> <li>Refer to Section 3.4 of this guide</li> </ul>

Table of contents		Key considerations and reporting requirements		Supporting information
		All assessments (where column is not split)		
Section	Subsection	Simple assessment	Detailed assessment	
		<ul style="list-style-type: none"> <li>effectiveness, limitations and any necessary additional requirements to address risk to the development and its users or offsite impacts</li> <li>residual risks to users of the development</li> </ul>		
8. Conclusions and recommendations		Describe and document: <ul style="list-style-type: none"> <li>conclusions</li> <li>management measures to reduce flood impacts and any residual impacts and recommendations including mapping and GIS outputs</li> <li>compatibility or deviation from consent authority requirements</li> </ul>		
9. References		List key references used in the report		
Appendices	A1	Appendix containing: <ul style="list-style-type: none"> <li>figures to support the assessment are included in this section</li> <li>figures of management measures and final proposed layout including GIS outputs</li> </ul>		<ul style="list-style-type: none"> <li>Refer to Table 6 below</li> </ul>
	A2	Appendix to include data collected or input data used		
	A3	Appendix containing: <ul style="list-style-type: none"> <li>animation of flood event</li> <li>GIS/waterRIDE files</li> <li>reporting requirements</li> <li>model files (depending on licensing)</li> </ul>		<ul style="list-style-type: none"> <li>Refer to Table 6 below</li> </ul>

**Table 6 Typical outputs to be included in the FIRA report to support the proposal**

Model	Existing case	Developed case	Calibration and validation	Typical required design events *				
				5% &/or 10% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
Hydrology	Map: Catchment and sub-catchment areas, site and hydrologic and hydraulic controls	Identify any changes in flowpaths, flow entry or discharge points						
	Map: Model parameterisation	Highlight any differences						
	Plot: Storm events examined highlighting events selected for hydraulic modelling	Highlight any differences		✓	✓	✓	✓	✓
	Plot: Hydrographs at gauge locations, site boundaries and hydraulic controls	Compare to existing	✓	✓	✓	✓	✓	✓
	Tabulate: Critical storm durations for different aspects selected for hydraulic modelling	Compare to existing		✓	✓	✓	✓	✓
	Plot: Hydrographs for key events used in hydraulics	Compare to existing	✓	✓	✓	✓	✓	✓
Hydraulics and post processing	Map: Study area, site and hydraulic controls	Identify any changes in flowpaths, flow entry or discharge points						
		Map: Development site with proposed works						
		Site cross-sections: Showing changes due to the development (including cut/fill and vegetation)						
	Map: Model parameterisation	Highlight any differences						
	Map: Peak flood extents	Compare to existing, include properties impacted	✓	✓	✓	✓	✓	✓
	Map: Peak flood depth	Compare to existing			✓			
	Map: Peak flood level (m AHD) and chainages for long section	Compare to existing			✓			



Flood Impact and Risk Assessment

Model	Existing case	Developed case	Calibration and validation	Typical required design events *				
				5% &/or 10% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
	Long section: Waterway invert with peak flood level (m AHD) at key locations	Compare to existing		✓	✓	✓	✓	✓
	Tabulate: Peak flood level (m AHD) at key locations	Compare to existing		✓	✓	✓	✓	✓
	Map: Peak flood velocity and identify key points	Compare to existing			✓			
	Map: Flood hazard	Compare to existing		✓	✓	✓	✓	✓
	Map: Flood function	Compare to existing		✓	✓	✓	✓	✓
	Map: Flood emergency response classification	Compare to existing		Consider range of floods and other mapping				
	Map: FPCCs or undertake mapping consistent with councils existing DCPs, e.g. flood risk precincts or similar	Compare to existing		Consider range of floods and other mapping				
	Map: Impacts of climate change on flooding	Consider and manage impacts on proposed development				✓	✓	
	Plot: Output hydrographs at key locations (changes to timing/duration)	Compare to existing, consider and manage impacts on existing and proposed development		✓	✓	✓	✓	✓

Note: \* Design events may vary considering the requirements of the consent authority and in areas of interaction between ocean and catchment flooding