Regional Flood Database:

Flood Impact Assessment Guideline

Moreton Bay Regional Council

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Notice

Table of Contents

1 Introduction

1.1 Purpose

To assist in the assessment of a proposed development, Moreton Bay Regional Council's Planning Scheme Policies may require localised flood investigations in the form of a Flood Impact Assessment Report or a Site Based (Localised) Flood Report.

As per the Planning Scheme Policy - Stormwater Management, a Flood Impact Assessment Report will be required if the development site is located adjacent to a waterway or a waterway is traversing through the site, and:

i. The site is likely to be significantly affected by flooding or;
ii. The development proposal is likely to affect the waterway characteristics including changes to the waterway that may affect the hydraulic capacity and flood behaviour of the waterway.

As per the Planning Scheme Policy - Flood Hazard, Coastal Hazard and Overland Flow, a Site Based (Localised) Flood Report is a requirement for development involving filling and excavation on land affected by the Flood hazard overlay or Coastal hazard overlay. Specifically, a Site Based (Localised) Flood Report is required to accompany a development application for the following activities:

i. development involving filling in any part of the Coastal planning area, as defined in the Coastal hazard overlay;
ii. development involving filling in the Medium or Balance flood planning area, as defined in the Flood hazard overlay.

A Site Based (Localised) Overland Flow Report is required for new development, minor works or filling within the Overland flow path overlay.

Both the Flood Impact Assessment and Site Based (Localised) Flood technical reports perform the same function, which is to document the outcomes of a localised flood investigation that has been carried out in support of the development.

Moreton Bay Regional Council requires that assessment of flood behaviour and risk considers multiple flood events, including a range of probabilities and durations.

The purpose of this guideline is to supplement the information available within the Planning Scheme Policies regarding undertaking localised flood investigations and preparation of these technical reports, considering the context of Council's Regional Flood Database. This guideline may additionally be useful for those undertaking other flood modelling work for Council. Whilst mention is made of overland flow, this document does not focus on providing guidance for Site Based (Localised) Overland Flow Reports.

2 Regional Flood Database

2.1 Background

The Regional Flood Database (RFD) is a hydrologic and hydraulic model library that is capable of seamless interaction with a spatial database to efficiently deliver detailed information about flood behaviour across the Moreton Bay Regional Council (MBRC) area.

The RFD model library includes fourteen calibrated and validated coupled hydrologic and hydraulic models, one for each of the fourteen 'minor basins' within the Moreton Bay Regional Council area (see below figure). The hydrologic modelling platform is Watershed Bounded Network Model (WBNM) and the hydraulic modelling platform TUFLOW (classic). The models were built around 2009 and updated between 2013 and 2016 (most in 2014). Hydraulic modelling scenarios include both river and creek flood scenarios and storm tide inundation scenarios.

The RFD additionally includes Storm tide models, which are provided together with the river/creek models as described within Section 2.4.

Overland flow models also form part of the RFD database however, these models are not available for purchase. The Overland Flow layer (in the MBRC Planning Scheme) is derived from these models as a trigger for further investigation. A Site Based (Localised) Overland Flow Report is a requirement for development that is proposed to be located in a

Document Set ID: 66573809
Version: 6, Version Date: 03/04/2023

designated overland flow path as defined by the Overland flow path overlay. The developer is required to prepare this based on their proposed development.

The RFD flood modelling results are used to populate Council's Flood Check Property and Development Reports, as well as to determine the risk categories for the Flood Hazard and Coastal Hazard Overlays. The RFD is also used to populate an interactive mapping tool (Moreton Bay Flood Viewer), which is a useful tool for becoming familiar with flood behaviour within the Moreton Bay area.

All models are built in a consistent manner. Model hydrology is based on Australian Rainfall and Runoff 1987 guidelines. Council's flood study and investigation reports provide details about the adopted modelling methodologies, model run times and memory requirements for the catchment models. The reports can be downloaded free of charge from Council's web site https://www.moretonbay.qld.gov.au/Services/Property-Ownership/Flooding/Flood-studies-and-reports

Regional Floodplain Database Catchments

2.2 Current RFD Model versions

The current model generation is as per the below table.

Model Name and catchment size	Current RFD version
Brisbane Coastal Creeks (BCC) 40 km^2	G2 002c
Bribie Island (BRI) 43 km^2	G2 002c
Burpengary Creek (BUR) 87 km^2	G2 002c
Byron Creek (BYR) 7 km^2	G2 002c
Caboolture River (CAB) 382 km^2	G2 002c
Hays Inlet (HAY) 86 km^2	G2 002c
Lower Pine River (LPR) 308 km^2	G2 002d
Upper Mary River (MAR) 79 km^2	G2 002c
Neurum Creek (NEU) 132 km^2	G2 002c
Pumicestone Passage (PUM) 239 km^2	G2 002c
Redcliffe (RED) 22 km^2	G2 002c
Sideling Creek (SID) 53 km^2	G2 002c
Upper Stanley River (STA) 479 km^2	G2 002c
Upper Pine River (UPR) 348 km^2	G2 002c

2.3 Future updates to RFD Models

Council periodically reviews and updates the entire suite of RFD models.

New aerial photography and LiDAR captured in 2019 is currently being used to prepare an RFD update. This update will also consider new Australian Rainfall and Runoff 2019 guidance, as well as the availability of new TUFLOW solvers. The update is scheduled to complete in the second half of 2023. Over time, Council will make these new models available via licence for development assessment.

The RFD update will also include new and updated overland flow modelling.

2.4 2020 IFDs

Subsequent to the release of 2016 Intensity Frequency Duration (IFD) data as part of the Australian Rainfall and Runoff 2019 update, new IFDs were developed in 2020 for several local government areas (Lockyer, Ipswich, Moreton, Brisbane) using improved rainfall datasets and methods which increased local focus. The LIMB 2020 IFDs were peer reviewed and are now freely available for download on the ARR Data Hub website, https://data.arr-software.org/, with background information provided under the "Jurisdiction Specifics" tab (https://data.arr-software.org/limb_specific). Moreton Bay Regional Council formally adopted the LIMB 2020 IFDs in June 2022 (https://www.moretonbay.qld.gov.au/files/assets/public/council/meetings/2022/gm20220629-minutes.pdf).

The LIMB 2020 IFDs are currently being incorporated into the next version of the RFD models. In the interim, several council projects have utilised the LIMB 2020 IFDs in conjunction with Australian Rainfall and Runoff 1987 patterns and the current RFD models.

Australian Rainfall and Runoff 2019 recognised that future techniques and information would be developed subsequent to the publication of the guideline and states that use of new or improved procedures should be encouraged, noting peer review of new processes as a desirable attribute. Practitioners should hence be aware of the LIMB 2020 IFDs and the need for their use in projects.

2.5 Purchase of RFD Models

The RFD models and associated data are available under licence. In summary, the licence provides access to one of the catchment models, including the WBNM and TUFLOW input and results files, and an ArcGIS processing tool. They can be requested by completing a digital flood study data request form on Council's website https://www.moretonbay.qld.gov.au/Services/Reports-Policies/Flood-Studies/Data-Request

2.6 Fraction Impervious - Fully Developed Planning Scheme

The MBRC Planning Scheme provides Fraction Impervious values for each zone and/or precinct that can be used for modelling future conditions. A table can be found in **Section 1.11.5.1 Rational Method Calculation of Peak Flows in** in the Integrated Design document, Appendix C. This document is available on Councils website at MBRC Planning Scheme - Version 6 - Planning Scheme Policy - Integrated design - Appendix C (moretonbay.qld.gov.au)

Document Set ID: 66573809
Version: 6, Version Date: 03/04/2023

The following model files and data are supplied with a licenced RFD model package for a chosen minor basin and Option:

Model / Data	***Data delivered via digital file transfer***
Hydrologic model - WBNM	
• GIS files - Minor Catchments, Stream Reaches and Stream Junctions	All provided
a. Model run files	All provided
b. Model result files	○ 5, 10, 20, 50, 100 and 1,000 yr ARIs for 10 storm durations ○ 3 Moreton Bay Design Storm (MDS) simulations
Hydraulic model - TUFLOW (for both Flood and Storm Tide where applicable)	
c. GIS Files - MapInfo MID/MIF input files	All provided
d. Model input files, run files	All provided
e. Model results files	○ 20, 100 and 1,000 yr ARIs for 3-4 durations (varies depending on the minor basin) ○ None for MDS
f. Result file formats	○ flt max grids for h, d, V, Z0, ZQRA, ZMBRC (Flood modelling) and Z9 (Storm Tide modelling) ○ Other result files available on request
g. Landuse input files based on 2013 Aerial photography	All provided
h. LiDAR (2014) (within the model code boundary)	All provided
i. LiDAR (2019) (within selected catchment boundary), as well as modifiers for post LiDAR developments where applicable and available. One or more of the following formats can be used for the modifiers: txt, 12da, asc, MID/MIF, grd and tin.	All provided
Tool for calculating risk categories for the Flood Hazard and Coastal Hazard Overlays	Provided as an ArcGIS tool.

For other GIS information (eg Planning Scheme layers, aerial photography) please contact Council - gis@moretonbay.qld.gov.au. Please note a separate agreement may be required for any GIS data.

2.7 RFD Naming Convention

To simplify the review and maintenance process for the RFD models, a strict naming convention was adhered to during model development. A document describing the file naming convention is provided as Appendix B. It is not mandatory that the consultant follow this naming process for the purpose of an impact assessment.

An explanation of scenarios within the models is as per the below table.

ID	Description	Purpose	Minor Basins	Method
RE_R01	Increase manning's n by 20%	Test sensitivity of model results	All	Increase all manning's n values by 20% in TUFLOW model.
RE_R02	Model blockage of culverts	Test sensitivity of model results	All (excl. BYR & MAR)	Moderate blockage - refer SKM report. Only applies to 1d_culverts and not to 1d_network files.
RF_R03	Model impact of increased rainfall	Test Climate Change impacts	All	Increase rainfall by 20% - refer SKM report for method. WBNM model to be updated and re-run to generate new inflow for TUFLOW model.
RF_R04	Model impact of an increased downstream boundary	Test Climate Change impacts	BRI, PUM, CAB, RED, HAY, LPR, BUR	Change downstream boundary to MHWS + 0.8m.
			BCC, NEU, STA, MAR, BYR	Increase TWL to 5000yr ARI level.

RF_R05	Model impact of increased rainfall and downstream boundary (R03 + R04)	Test Climate Change impacts	ALL (excl. SID & UPR)	Increase rainfall by 20% - refer SKM report for method, Change downstream boundary to (MHWS + 0.8m) or (5000yr ARI level).
RE_R06	Model impact of existing rainfall with current static storm tide boundary - 100yr	Reference for storm tide impacts	BRI, PUM, CAB, RED, HAY, LPR, BUR	Existing Rainfall, Change downstream boundary to Static ST Level (100yr Current). Refer Table 3 for storm tide values.
RF_R07	Model impact of Increased Rainfall (R03) + Increase in Sea level (R04) + Static storm tide level (100yr GHG)	Test Climate Change impacts for a 100yr horizon	BRI, PUM, CAB, RED, HAY, LPR, BUR	Increase rainfall by 20% - refer SKM report for method, Change downstream boundary to Static ST level (100yr GHG) + 0.8m. Refer Table 3 for storm tide values.
RF_R08	Model impact of increased vegetation in floodplains	Test future development impacts	All	Change Medium Dense Vegetation to High Dense Vegetation within the 100yr floodplain.
				Change Low grass/grazing to Medium Dense Vegetation within the 100yr floodplain.
RF_R09	Model impact of increased residential development	Test future development impacts	BCC, LPR, UPR, HAY, BUR, CAB, STA, PUM, BRI, RED	Minor catchments with updated FI will be provided by Council. WBNM model to be updated and re-run to generate new inflow for TUFLOW model.
RF_R10	Model impact of increased residential development and increased vegetation in floodplains	Test future development impacts	BCC, LPR, UPR, HAY, BUR, CAB, STA, PUM, BRI, RED	Combine R08 and R09.

3 Localised Flood Investigation Requirements

3.1 Objective

The objective of the flood investigation is to demonstrate that the proposed development, with any necessary on-site mitigation infrastructure and satisfying the Defined Flood Event (DFE) and Flood Planning Level (FPL) requirements, does not result in adverse offsite impacts (compared to the base case scenario) to:

i. Flood Behaviour - including adverse increases to flood levels, velocities and peak flows to offsite properties, impediments to floodwaters across the site, and significant changes to flow paths in a range of flood events.
ii. Flood Risk - including increases to Council's risk categories (as created from all the relevant critical durations for the 5% AEP, 1% AEP and 0.1% AEP events) and adverse impacts to flood warning times to surrounding properties or elsewhere on the floodplain

Where the assessable development for the DA is the first stage of a broader scheme (e.g. fill of a lot to create the first part of a new residential subdivision, with fill of adjacent lots and extension of the subdivision to occur in the future), the flood investigation is to consider the cumulative impact of the future development.

3.2 Scope

The scope of the localised flood investigation is to generally accord with the following. For a range of AEPs and flood durations:

i. investigate the hydraulic characteristics of the waterway for the pre- and post-development scenarios;
ii. determine whether the development is likely to cause any adverse impacts to upstream or downstream properties;
iii. determine whether the cumulative impact of development is likely to cause an adverse impact on other properties elsewhere in the floodplain; and

Document Set ID: 66573809
Version: 6, Version Date: 03/04/2023

iv. determine the flood mitigation requirements and demonstrate that they can be implemented through on-site works.

As stated in Section 2, the RFD is currently based upon ARR 1987 guidance, and is in the process of being updated according to ARR 2019 guidance. During this transitory period, Council recommends practitioners continue to follow ARR 1987 guidance for hydrology until Council has established a methodology for the application of ARR 2019.

3.3 Adverse Impacts Criteria

An adverse off-site impact in events up to and including 1% AEP event is defined by the following conditions:

i. Flood or Storm Tide levels increase on State controlled road and rail infrastructure (amount of tolerable impact to be determined in consultation with TMR/QR as appropriate); or
ii. Flood or Storm Tide levels increase by more than 0.02 m on privately owned land. Larger impacts on Council owned land may be acceptable in consultation with Council; or
iii. Flow velocities increase by more than 0.1 m/s offsite; or
iv. Significant increase to peak flow across the development boundary, with consideration of neighbouring land use, existing flood extent and magnitude of peak flow.
v. Significant impact to trafficability of local roads, such as a reduction in road immunity or increase in flood hazard across road that affects vehicle safety;

Additionally, an adverse off-site impact includes any increase to the risk categories within the Flood or Coastal Hazard Overlays.

For events more rare than the 1% AEP event, impacts must be as low as reasonably practicable. An adverse off-site impact in these scenarios may include;

i. Inundation above floor level of a property that is not inundated above floor level in the pre-development scenario
ii. Development causes a sudden rate-of-rise of flood waters on offsite properties in a very rare flood event
iii. Other impacts that adversely increase danger to and damage of people, property and the environment
iv. Other impacts as prescribed within development assessment conditions

3.4 Modelling Software

The flood investigation, also often referred to as a flood impact assessment, will typically need to include both hydrologic and hydraulic modelling. Council encourage floodplain management practitioners to undertake flood investigations utilising the Regional Flood Database tools and models. It is recommended that all modelling should be undertaken in accordance with the RFD methodology.

In some cases it may be desired to use alternate software, depending on the nature and scale of the hydraulic behaviour being assessed. As a minimum, the selected model must offer capabilities sufficient to adequately represent the complexity of the floodplain and catchment in a form equivalent to or exceeding the capabilities offered by the RFD WBNM/TUFLOW models. Justification of adoption of alternative software must be provided within the technical report.

All inputs into the models must be in accordance with the relevant standards included in the Integrated Design Planning Scheme Policy and as otherwise stated in this guideline.

3.5 Modelling Method

Consultants are required to prepare pre- and post-development scenario modelling (hydrologic and hydraulic) for the area of interest.

MBRC encourage consultants to utilise a RFD WBMN model and (as appropriate) prepare a localised (”cut-down”) version of a RFD TUFLOW model to assess the flood impacts of the proposed development. The following needs to be considered, undertaken and documented in the technical report:

<u>Cut-down model; June 2014 Conditions (Existing MBRC RFD flood model conditions)</u>

Where a cutdown model is prepared to enhance runtimes and improve data management, as a first step the consultant must demonstrate the cut-down is an adequate proxy for the full RFD model within the vicinity of the area of interest. This will generally require the following to be undertaken and documented:

i. The boundaries of the cut-down RFD TUFLOW model must be located at a sufficient distance from the area of interest so as to not be a controlling influence on flood behaviour in that area. Typically, MBRC would expect upstream and downstream boundaries to be at least 2 km from the area of interest and aligned with existing RFD PO lines, if appropriate. In flat catchment areas, boundaries may need to be farther away. Conversely, in steeper catchment areas, it may be appropriate that boundaries be closer than 2 km. The technical report will need to demonstrate that impacts and mitigation measures of the proposed developments are independent of the chosen cut-down model boundary locations for a range of flood durations and AEPs.
ii. Demonstrate that the cut-down hydraulic model accurately reproduces the RFD flood behaviour including flood levels, velocities and hydraulic hazard (ZMBRC - refer to Appendix A) for multiple durations and AEPs within the area of interest and a sufficient area upstream and downstream of the study site. This can be demonstrated by providing peak result difference maps. It is understood that some boundary effects may remain, but these must not influence flood behaviour in the area of interest as well as being located sufficiently upstream and downstream. As a minimum, this assessment should consider the 5%, 1% and 0.1% AEP events, for the relevant critical durations.
iii. It is recognised that recent TUFLOW solvers and executables may produce different peak water surface levels for a given flow input as compared to the solver/executable used to produce the RFD outputs. Using a solver and executable other than that employed by the RFD hence requires due consideration. As the RFD models have been calibrated, it is nonetheless required that the cut-down model accurately reproduce the RFD model flood results. This may require adjustments to model parameters, such as Manning's n values, within the cut-down model.
iv. If changes to the RFD sub-catchment breakdown are required to better represent rainfall runoff distribution in the area of interest, the resulting changes (if any) to the flood behaviour shall be documented and justified, particularly where a revised representation of flood behaviour is to be used for the impact assessment.
v. All revisions to MBRC models (WBMN and/or TUFLOW) to reproduce RFD conditions need to be justified and documented.

<u>Pre-development Conditions (Base Case)</u>

As the current MBRC RFD models were last updated around 2014 to 2016, aspects of these models may be out-of-date and not represent the current base case for a localised impact assessment. As such, there may be a need to update model data to reflect present-day pre-development conditions. This will require the following:

i. Update hydrologic and hydraulic models to reflect any catchment changes post June 2014. Hydraulic model topography should be updated to reflect 2019 LiDAR data. All changes to topography, landuse (fraction impervious and Manning's n), flow paths, structures etc. required to produce pre-development conditions need to be documented and justified.
ii. Execute simulations for an appropriate range of flood events; at minimum, the relevant critical durations for the 5%, 1% and 0.1% AEP events, plus the relevant DFE scenarios.
iii. Determine flood levels, velocities and hydraulic hazard (ZMBRC) for these events (hydraulic hazard not required for DFE scenarios).
iv. Determine the risk categories as per the MBRC combined flood risk matrix (refer to Appendix A). MBRC's flood model packages provide an ArcGIS tool for calculating the risk categories for the Flood and Coastal Hazard Overlays (i.e high and medium risk flood hazard areas).
v. Document and justify differences between the developed base case model and the cut down model (if prepared) or RFD model (if cutdown not used)

<u>Proposed Development Scenario</u>

The Proposed Development Scenario may include mitigated conditions, unmitigated conditions, interim stages of the development, and a best estimate of the ultimate development. For the relevant proposed development scenarios;

i. Update hydrologic and hydraulic models to incorporate the proposed development conditions. All changes to topography, landuse, flow paths, structures etc. required to represent development conditions need to be documented along with justification for the parameters used to represent these changes in the hydrologic and hydraulic models. Particular detail regarding how the proposed development topographical modifications were implemented into the hydraulic model is required.
ii. Execute simulations for the range of chosen flood events; at minimum, the relevant critical durations for the 5%, 1% and 0.1% AEP events, plus the relevant DFE scenarios.
iii. Identify flood levels, velocities and hydraulic hazard (ZMBRC) for these events (hydraulic hazard not required for DFE scenarios).
iv. Determine the risk categories following the MBRC combined flood risk matrix (refer to Appendix A)
Determine and/or confirm the flood planning level to be applied across the proposed development.

3.6 Additional Assessment

As stated in the Stormwater Management Planning Scheme Policy, a Flood Impact Assessment Report requires the flood storage volume to be determined by computer model based on pre and post development field contour surveys.

3.7 Reporting

The following guidance is provided regarding MBRC's expectations on the content and level of detail required for a Flood Impact Assessment Report or a Site Based (Localised) Flood Report.

These technical reports are to contain, as a minimum, the following:

i. Objective and scope of flood investigation
ii. Property details for the development site for pre- and post-development scenarios, as well as any interim stages, including site survey plans and/or maps showing drainage easements, waterway corridors, cadastral boundaries, ground levels, earthworks (cut and fill areas), road levels, drainage structures, pipe invert levels and pit surface levels.
iii. Modelling Methodology
    a. flood model layout maps;
    b. data inputs, including their source;
    c. software executable version and computation solver utilised
    d. discussion and justification of model modifications undertaken as compared to RFD model and chosen modelling parameters; including model code boundary, boundary conditions, ground elevations, adopted surface roughness (landuse mapping and Manning's n categories) and structures/infrastructure incorporated;
    e. discussion and justification of chosen model modifications undertaken to represent the various scenarios (pre-development and development scenario/s)
    f. modelling assumptions and limitations;
    g. results of any sensitivity testing of key parameters;
    h. events, storm durations, climate and catchment conditions utilised in the modelling;
    i. details regarding the critical duration analysis undertaken for the investigation area;
iv. Cut-down model results and validation
    a. verification results, including difference maps showing that the cut-down base case model (June 2014 pre-development conditions) accurately reproduces the RFD flood behaviour (flood levels, velocities and hydraulic hazard) for multiple durations and AEPs (at minimum the 5%, 1% and 0.1% AEP events) within the area of interest and a sufficient area upstream and downstream of the study site.
v. Pre-development scenario (base case) model results
    a. catchment plan showing sub-catchments and flow paths for pre-development conditions;
    b. model results for flood behaviour, including providing a series of maps showing levels, depths, velocities, hazard and MBRC combined flood risk for pre-development conditions.
vi. Development Scenario/s results
    a. catchment plan/s showing sub-catchments and flow paths for the ultimate development conditions and any interim stages;
    b. model results for flood behaviour, including providing a series of maps showing extents, levels, depths, velocities, hazard and MBRC combined flood risk for the ultimate development conditions and any interim stages.
vii. Impact Analysis and Mitigation Assessment
    a. discussion and assessment of impacts of flooding within the proposed development;
    b. discussion and assessment of the impacts of the proposed development (ultimate development conditions and interim stages) on flooding elsewhere, including confirmation that there are no adverse off-site impacts as a result of the proposed development (see Section 3.3);
    c. discussion and assessment of flood mitigation measures required to ensure no adverse off-site impacts, including demonstration that the flood mitigation measures can be implemented through on-site works;
    d. provide impact maps / difference plots between pre- and post-development scenarios for flood levels, velocities, hazard and risk categories for the 5%, 1% and 0.1% Annual Exceedance Probability (AEP) events and the DFE for Flood and Storm Tide, where applicable. Impact maps need to show increases and decreases in peak flood level as well as was "wet now dry" and "was dry now wet" areas.

The following difference ranges should be shown on all peak flood level impact maps:

Reduction > 500mm	Increase 20 - 50mm
Reduction 200 - 500mm	Increase 50 - 100mm
Reduction 100 - 200mm	Increase 100 - 200mm
Reduction 50 - 100mm	Increase 200 - 500mm
Reduction 20 - 50mm	Increase > 500mm
Reduction 20mm - Increase 20mm	Decreased flood extent
	Increased flood extent

Document Set ID: 66573809
Version: 6, Version Date: 03/04/2023

The following difference ranges should be shown on all velocity impact maps:

- Less than -1
- -1 to -0.5
- -0.5 to 0
- 0 to 0.25
- 0.25 to 0.5
- 0.5 to 1
- 1 to 1.5
- 1.5 to 2
- 2 to 3
- Greater than 3
- Increase in flood Extent

The following colour pallet should be shown when mapping the flood hazard overlay:

Flood Hazard Risk

- **Balance flood planning area**
- **Medium risk flood hazard area**
- **High risk flood hazard area**

The following difference ranges should be shown on all risk impact maps. It is important that the correct layer ordering is followed (i.e. High Hazard Extent Increased layer is shown atop of all other layers, Balance Area Extent Reduced layer beneath all other layers). Note; balance area reductions do not need be calculated if the PMF event has not been modelled.

- **High Hazard Extent Increased**
- **Medium Hazard Extent Increased**
- **Balance Area Extent Increased**
- **High Hazard Extent Reduced**
- **Medium Hazard Extent Reduced**
- **Balance Area Extent Reduced**

viii. All plans and maps provided in the technical reports, including flood maps, need to include the following:
   a. clear title/description;
   b. scale and legend;
   c. site boundary; and
   d. additional relevant site details (e.g. stage boundaries, development areas, cut and fill areas including batters, constraint areas, mitigation works etc.)
   e. relevant details for areas surrounding the development site (e.g. road names, suburb names and cadastral data)

ix. Statements of compliance with the relevant requirements in the overall outcomes and performance outcomes outlined in the applicable codes.

3.8 Data Provision

The final models, with all associated input data files and results as detailed below, may be requested by Council for review purposes:

i. Hydrology and hydraulic modelling files in working form, including batch files;
ii. Output files from the hydrologic and hydraulic models (flt grids);
iii. All post-processed results, including all GIS related files created; and

iv. A model log describing the relevant model names, scenarios, and key differences between these.

4 Appendix A

A copy of Figure 1 Hydraulic Hazard Categorisation (Flood (River and Creek)) from Council's Planning Scheme Policy - Flood hazard, Coastal Hazard and Overland Flow is provided below and demonstrates the derivation of the hydraulic hazard categories (ZMBRC) utilised by Council.

Figure 1 Hydraulic Hazard Categorisation (Flood (River and Creek))

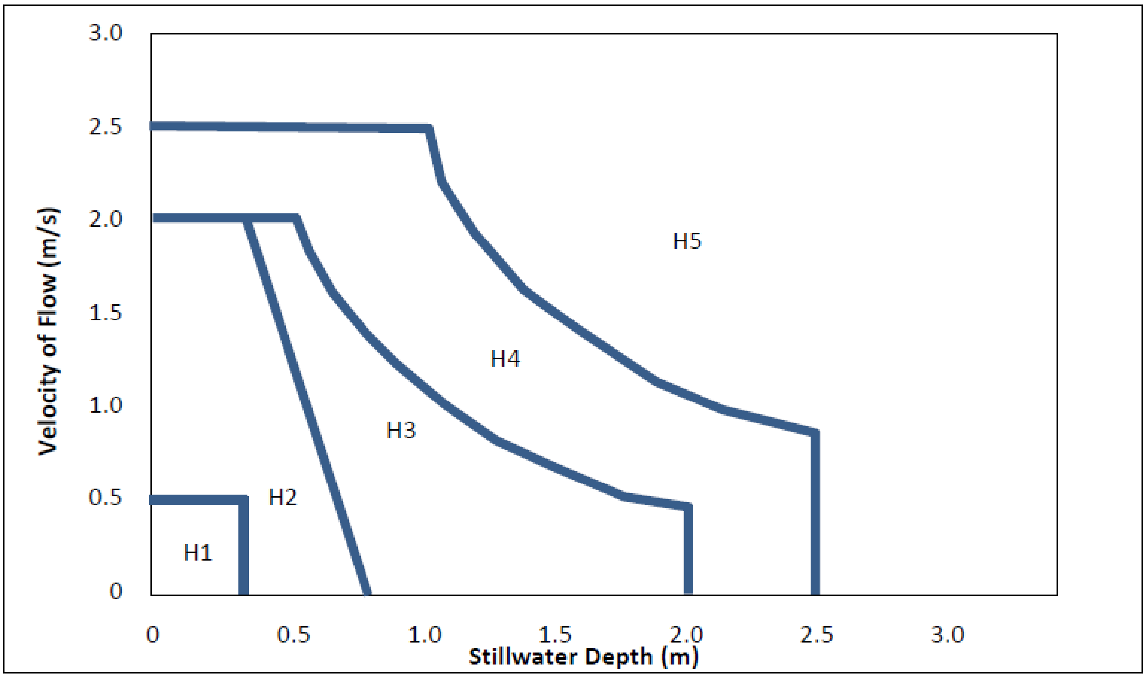

Table 1 below provides the depth and velocity values for Council's hydraulic hazard categories depicted in Figure 1 above, in a format as used by WaterRIDE.

Table 1 Hydraulic Hazard Categorisation (Flood)

	Depth	Velocity		Depth	Velocity		Depth	Velocity
H1	0	0	H4	2	0	H5	2.5	0
	0.3	0		2.5	0		100	0
	0.3	0.5		2.5	1		100	100
	0	0.5		2.25	1.11		0	100
H2	0.3	0		2	1.25		0	2.5
	0.8	0		1.5	1.67		1	2.5
	0.3	2		1.25	2		1.25	2
	0	2		1	2.5		1.5	1.67
	0	0.5		0	2.5		2	1.25
	0.3	0.5		0	2		2.25	1.11
H3	0.8	0		0.3	2		2.5	1
	2	0		0.5	2			
	2	0.5		0.6	1.67			
	1.5	0.67		0.75	1.33			
	1.2	0.83		1.2	0.83			
	0.75	1.33		1.5	0.67			
	0.6	1.67		2	0.5			
	0.5	2						
	0.3	2						

A combined flood risk matrix was developed by Council that describes the level of risk based on likelihood (i.e. the frequency of an event occurring) and the consequence (i.e. the hydraulic hazard category) and was utilised to determine the risk categories for the Flood and Coastal Hazard Overlays. A copy of Figure 3 from Council's Planning Scheme Policy - Flood hazard, Coastal Hazard and Overland Flow has been provided below.

Council provides an ArcGIS toolbox for calculating risk categories for the Flood Hazard and Coastal Hazard Overlays. Inputs for this tool include the 5%, 1% and 0.1% AEP hazard rasters.

Figure 3 Combined flood risk matrix

Likelihood level		*NERAG 2010*[1]	**Consequence level**				
Current MBRC flood mapping (Flood Check)			*Insign-ificant*	*Minor*	*Moderate*	*Major*	*Catastr-ophic*
Coastal hazard (storm tide inundation)	*Flood hazard*						
0.01% AEP 2014 (1:10,000 ARI)	River and Creek Floodplain Extent (PMF)	*Rare*	T-VL	T-VL	T-L	T-L	T-L
0.1% AEP 2014 (1:1,000 ARI)	0.1% AEP 2014 (1:1,000 ARI)	*Unlikely*	T-L	T-L	T-M	I-H	EI-H
1% AEP 2014 (1:100 ARI)	1% AEP 2014 (1:100 ARI)	*Possible*	T-M	T-M	T-M	EI-H	EI-H
5% AEP 2014 (1:20 ARI)	5% AEP 2014 (1:20 ARI)	*Likely*	T-M	T-M	T-M	EI-H	EI-H
Hydraulic Hazard category			*H1*	*H2*	*H3*	*H4*	*H5*
Risk to Life and Property			*Low*		*High*		
Approximate floodplain hydraulic category			*Flood fringe*	*Flood storage*		*Floodway / flood conveyance*	

EI-H	Extremely Intolerable High Risk
I-H	Intolerable High Risk
T-M	Tolerable Medium Risk
T-L	Tolerable Low Risk
T-VL	Tolerable Very Low Risk

1. National Emergency Risk Assessment Guidelines October 2010 (NERAG 2010)

High risk areas defined on the hazard overlays approximately accord with areas that are categorised as Intolerable (I-H) risk and Extremely Intolerable (EI-H) risk, while Medium risk areas on the overlays mostly accord with areas of Tolerable-Medium (T-M) risk.

For further details please refer to Council's Planning Scheme Policy - Flood hazard, Coastal Hazard and Overland Flow, which is available from Council's website
https://www.moretonbay.qld.gov.au/Services/Building-Development/Planning-Schemes/MBRC/Policies

5 Appendix B

HYDROLOGIC AND HYDRAULIC MODEL FILE NAMING AND OUTPUT CONVENTION

Introduction

The Moreton Bay Region is divided into 14 catchments for the purpose of flood modelling. For each of these catchments Council maintains a series of hydrologic and hydraulic models.

In order to simplify the process of review and periodic maintenance of these models, Council requires adherence to a strict model naming convention. The convention includes short identifiers that describe different variables associated with a model scenario. There are also a number of strict requirements with respect to model output.

This document describes these model file naming and output conventions and is intended to assist modelling teams when preparing and maintaining flood models for Council.

Note that the naming convention has been prepared specifically to manage hydrologic and hydraulic model files. At the completion of the modelling process, the model output data is imported into Council's spatial information database (by Council staff) using a different naming convention (documented separately). A different convention is necessary to satisfy the different needs that arise during the management and publication of spatial data.

Hydrologic Model Files

The following model file naming convention is to be used when preparing hydrologic models using Council's nominated software WBNM.

[Minor Basin]_[Model Version]_[Time Horizon]_[Event ARI][Event Duration]_[Scenario]

For example:

CAB_002c_E_00100Y0060M_R03 *(this corresponds to example in Table 1 below)*

UPR_002c_E_00050Y0030M

UPR_002c_E_MDS_R03

UPR_002c_F_MDS_R09

STA_002c_H_Jan2011

UPR_002c_E_99999Y0030M

The component variables that join to form the overall model file name are described in Table 1. Further information regarding the possible range of variable values is listed in Table 2.

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Table 1: Description of Hydrologic Model File Naming Convention

Variable	Description of Variable	Short Identifier Example	Description of Example
[Minor Basin]	Code given to each catchment within the region (three letters)	CAB	Caboolture River
[Model Version]	Model version number (three numbers and single letter)	002c	A second generation model at revision c. Referred to by Council as "002c"
[Time Horizon]	The time horizon considered when establishing model catchment and climate (one letter)	E	Existing catchment and climate conditions
[Event ARI]	Probability of the event expressed in years (five numbers followed by the letter Y)	00100Y	100 year Average Recurrence Interval
[Event Duration]	Duration of the event expressed in minutes (four numbers followed by the letter M)	0060M	60 Minute Duration
[Scenario]	Specific model scenario where one or more of the model parameters have been adjusted from the base model (one letter and two numbers)	R03	A model scenario that Council refers to as "R03".

Table 2: Range of Hydrologic Model File Name Variable Values

Variable	Range of Values
[Minor Basin]	The following 14 triple letter codes are applied to the modelled catchments: BCC, BRI, BUR, BYR, CAB, HAY, LPR, MAR, NEU, PUM, RED, SID, STA, UPR
[Model Version]	A register of values is maintained by Council and will be supplied to the modelling team on commencement.
[Time Horizon]	Existing = E (used for flood awareness and emergency mapping) Future = F (typically used for future planning scenarios) Historic = H (typically used for calibration and validation models)
[Event ARI]	As per Australian Rainfall & Runoff with the following exceptions: - Probable Maximum Flood = 99999 - Moreton Bay Design Storm = MDS - Historic Event = Jan2011
[Event Duration]	As per Australian Rainfall & Runoff with the following exceptions: - No duration code is applied to historic events. - No duration code is applied to the MDS event.
[Scenario]	A register of values is maintained by Council and will be supplied to the modelling team on commencement. - No scenario code is applied to historic events

	- No scenario code is applied to the base existing condition model

Hydraulic Model – Non-Spatial Input Files

The following model file naming convention is to be used when preparing hydraulic models using Council's nominated software TUFLOW. Specifically this convention relates to the non-spatial input files (e.g. *.tcf and *.tgc). Further information is provided in a later section of this document regarding spatial input files.

[Minor Basin]_[Flood Type]_[Model Version]_[Time Horizon]_[Event ARI][Event Duration]_[Scenario]_[Grid Size]_[Run No.]

For example:

CAB_R_002c_F_00100Y0060M_R03_5m_01 (this corresponds to example in Table 3 below)

CAB_R_002c_E_00050Y0030M_5m_05

BUR_R_002c_H_Jan2011_5m_01

CAB_R_002c_E_99999Y0030M_10m_05

BUR_S_002c_F_00100Y_S07_5m_03

BUR_S_002c_E_00020Y_5m_03

The component variables that join to form the overall model file name are described in Table 3. Further information regarding the possible range of variable values is listed in Table 4.

Table 3: Description of Hydraulic Model File Naming Convention

Variable	Description of Variable	Short Identifier Example	Description of Example
[Minor Basin]	Code given to each catchment within the region (three letters)	CAB	Caboolture River
[Flood Type]	Type of flow behaviour being modelled. Introduced to allow distinction between riverine flood and storm tide models (one letter)	R	Riverine flooding
[Model Version]	Model version number (three numbers and single letter)	002c	A second generation model at revision c. Referred to by Council as "002c"
[Time Horizon]	The time horizon considered when establishing model catchment and climate (one letter)	F	Future catchment and climate conditions

Table 3: Description of Hydraulic Model File Naming Convention

Variable	Description of Variable	Short Identifier Example	Description of Example
[Event ARI]	Probability of the event expressed in years (five numbers followed by the letter Y)	00100Y	100 year Average Recurrence Interval
[Event Duration]	Duration of the event expressed in minutes (four numbers followed by the letter M)	0060M	60 Minute Duration
[Scenario]	Specific model scenario where one or more of the model parameters have been adjusted from the base model (one letter and two numbers)	R03	A model scenario that Council refers to as "R03".
[Grid Size]	Adopted 2D model grid cell size (two numbers and one letter)	05m	5 metres
[Run No.]	Model run number used by modeller to track progressive iterations during the model build phase (two numbers)	01	First model iteration.

Table 4: Range of Hydraulic Model File Name Variable Values

Variable	Range of Values
[Minor Basin]	The following 14 triple letter codes are applied to the modelled catchments: BCC, BRI, BUR, BYR, CAB, HAY, LPR, MAR, NEU, PUM, RED, SID, STA, UPR
[Flood Type]	River and Creek = R Storm Tide = S
[Model Version]	A register of values is maintained by Council and will be supplied to the modelling team on commencement.
[Time Horizon]	Existing = E (used for flood awareness and emergency mapping) Future = F (typically used for future planning scenarios) Historic = H (typically used for calibration and validation models)
[Event ARI]	As per Australian Rainfall & Runoff with the following exceptions: - Probable Maximum Flood = 99999 - Moreton Bay Design Storm = MDS - Historic Event = Jan2011
[Event Duration]	As per Australian Rainfall & Runoff with the following exceptions: - No duration code is applied to historic events. - No duration code is applied to the MDS event. - No duration code is applied to event that only involve storm tide

Table 4: Range of Hydraulic Model File Name Variable Values

Variable	Range of Values
[Scenario]	A register of values is maintained by Council and will be supplied to the modelling team on commencement. - No scenario code is applied to historic events - No scenario code is applied to the base existing condition model
[Grid Size]	Council currently utilises two different model grid sizes; 5 metres and 10 metres. These two sizes are used for events of different magnitude within the same modelled minor basin. These are separately identified in each model file name as either '05m' or '10m'. In most cases the Mapinfo Input (MI) files will be common between these two grid sizes. Therefore this variable can be omitted from these MI input files unless different MI input files are required for each grid size in which case this variable should be used for the MI input files also.
[Run No.]	Starts at 01 and increments by 1 for each iteration as determined by modeller up to 99. Reset to 01 if new model version supplied by Council.

Hydraulic Model – Spatial Input Files

Often a single spatial input file is sufficient to represent a floodplain attribute which can then be referenced within a number of different model scenarios. For example the following three hydraulic model scenarios:

CAB_R_002c_F_00100Y0060M_R03_5m_01;

CAB_R_002c_E_00050Y0030M_5m_05;

CAB_R_002c_E_99999Y0030M_10m_05;

may all reference a single spatial input file '*CAB_002c_2d_flcsh_Bridge.mid/mif*' which defines the dimensions of bridges within the Caboolture River catchment.

The general form of a spatial input file is therefore:

[Minor Basin]_[Model Version]_[TUFLOW file name]_[Feature Description]

The [Minor Basin] and [Model Version] variables are the same as those defined in Table 3 above.

The [TUFLOW file name] variable is as per the suggested convention in the TUFLOW user manual.

The [Feature Description] variable is used to provide Council a meaningful description of the contents of the spatial file (e.g. Bridge, Culverts, TrunkDrains).

Hydraulic Model – PO Lines

The following naming convention is to be used to describe each PO (Plot Output) line within a PO spatial input file.

[Minor Basin]_[Major Catchment]_[Number]

For example:

LPR_SPR_001

BUR_BUR_078

BUR_LBC_015

UPR_NPR_001

The [Minor Basin] variable is the same as those defined in Table 3 above.

The [Major Catchment] variable is a similar triple letter identifier that relates to major tributaries of the minor basin. For example Four Mile Creek (FMC) is a major tributary of the Lower Pine River (LPR) minor basin. The main channel has the same major catchment code as the minor basin.

The [Number] variable is a simple sequential number starting at 001 for most upstream PO line within the major catchment. If it later becomes necessary to add PO lines after initial numbers are allocated it is acceptable to simply continue with the next number.

PO lines shall be drawn to cover the extent of the 2000yr ARI event. At bridges, PO lines shall consist of segments and be numbered as follows:

The segment of the PO line corresponding to the bridge must always include the suffix “a”, the segment of the PO line on the left hand side of the bridge (looking downstream) must always include the suffix “b” and the segment of the PO line on the right hand side of the bridge (looking downstream) must always include the suffix “c”.

*Hydraulic Model – Model Output Types to be Included in *.tcf file*

The following script is to be included in the *.tcf control file in order to ensure the required model output is available:

Map Output Format == XMDF | FLT | WRB (Note that Council has adopted the FLT format for efficiency reasons. Previously the ASC format was used)

Maximums and Minimums Time Series == ON

Maximums and Minimums Only For Grids == ON (This switch has been adopted to reduce the amount of post processing required)

WRB Map Output Data Types == h d v
XMDF Map Output Data Types == h d v q ZMBRC Z0 ZQRA SP Z9
FLT Map Output Data Types == h d v ZMBRC Z0 ZQRA SP Z9

Hydraulic Model – Post-Processing to create Maximum Value Grids

When post-processing to create a spatial file representing the envelope of maximum values (e.g. from a series of different event durations) the following naming convention must be used:

[Minor Basin]_[Flood Type]_[Model Version]_[Time Horizon]_[Event ARI]_[Grid Size]_[Run No.]_[Output Data Type]max.flt

An example of a batch file required to obtain this outcome using the '*asc_to_asc_W64.exe*' tool is as follows:

asc_to_asc_W64.exe –max –out ***CAB_R_002c_E_100Y_05m_02_dmax.flt***
CAB_R_002c_E_00100Y0060M_5m_02_d_Max.flt
CAB_R_002c_E_00100Y0120M_5m_02_d_Max.flt
CAB_R_002c_E_00100Y0180M_5m_02_d_Max.flt

The output file conforming to the required convention is shown using red font in the example script above.

Hydraulic Model – Post-Processing the Stream Power Grids

The tcf command "*Maximums and Minimums Only For Grids == ON"* does not apply to Stream Power (SP) and requires further post processing to extract SP from the xmdf files and then create a spatial file representing the envelope of maximum values (e.g. from a series of different event durations).

An example of a batch file required to obtain this outcome using the '*TUFLOW_to_GIS_w64.exe'*, '*asc_to_asc_W64.exe' and 'res_to_res.exe'* tools is as follows:

set t2g="Z:\Processing\TUFLOW_to_GIS_w64.exe"
set asc2asc="Z:\Processing\asc_to_asc_w64.exe"
set res2res="Z:\ Processing\res_to_res.exe"
set A=00001Y 00005Y 00010Y 00020Y 00050Y *(This can be a single event or multiple events as long as all the durations are the same)*

FOR %%a in (%A%) do (
%res2res% -b -out SID_%%a_max_SP.xmdf -max -typeSP SID_R_002c_E_%%a0060M_5m_04.xmdf SID_R_002c_E_%%a0180M_5m_04.xmdf SID_R_002c_E_%%a0360M_5m_04.xmdf
%t2g% -b -asc -path"Max Value" -sgs -2dm SID_R_002c_E_%%a0060M_5m_04.2dm SID_20Y_max_SP.xmdf
Rename SID_%%a_max_SPMaxMaxMax_Value_Max.asc ***SID_R_002c_E_%%a_05m_04_SPmax.asc***
)

*%asc2asc% -conv *.asc (This last step is required to convert the *.asc file to Councils preferred *.flt grid format)*

The output file conforming to the required convention is shown using red font in the example script above. This is the same naming convention as the previous section *Hydraulic Model – Post-Processing to create Maximum Value Grids*.